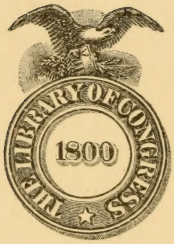


ELEMENTS OF

AGRICULTURE

A TEXT BOOK FOR PUBLIC SCHOOLS

BY

J. H. SHEPPERD

Dean of the Agricultural Division and Professor of Agriculture in the North Dakota Agricultural College

AND

J. C. McDOWELL

Professor of Agronomy in the North Dakota Agricultural College

WEBB PUBLISHING COMPANY

ST. PAUL, MINNESOTA

TABLE OF CONTENTS.

PREFACE.

There is a general movement all over the United States in the direction of placing Elementary Agriculture in the course of study for country schools. In order to secure a county teacher's certificate in Wisconsin, the applicant must pass an examination in elementary agriculture. The Missouri Agricultural College and the Missouri normal schools are carefully training teachers to present this subject in country schools. In South Carolina it is taught in the eighth and ninth grades of the common schools. In Nebraska the applicant for second-grade certificate is required to pass an examination in the elements of agriculture. Elementary Agriculture finds a place in the common-school course of study for the state of Illinois, and is even taught in some of the schools of our large cities. These instances suffice to show that the subject is receiving widespread attention.

During the past few years there have been several excellent books written on the subject of Elementary Agriculture for rural schools, but they are of necessity somewhat local in their treatment of the subject. Most of these books are from the east and south, a few from the middle west, but none from the northwest. As this subject has recently been added to the course of study for common schools in

North Dakota, it has seemed best to prepare a book written specially for the northwestern states. The conditions of soil and climate and the methods of farming are so different here from what they are elsewhere that it is difficult to use successfully a book that may be well adapted to other portions of the country.

In the preparation of this manual the authors have made an unusual arrangement of the subject-matter. The chief consideration relative to the grouping of topics has been, how can the interest of the student best be enlisted? A deep interest in, and a thorough respect for, a class-room subject, are prerequisite to success. The topics are arranged in nearly the same order that they are taken up in the course of study for the public schools of North Dakota. The course of study follows the seasons; the work on farm crops coming in the fall, that on domestic animals in the winter, and the work on soils and the beautifying of the home and school grounds forming a large part of the course during the spring months. If time permits, an occasional exercise in grain judging may be introduced at any time during the year. The assembling of the themes treated in this volume has been in accord with the plan which our experience indicates is best calculated to enlist the sympathy and hold the attention of the students. Bring forward the actual plant or animal for study, and it will, if the exercise is well planned and judiciously conducted, always prove attractive to the learner.

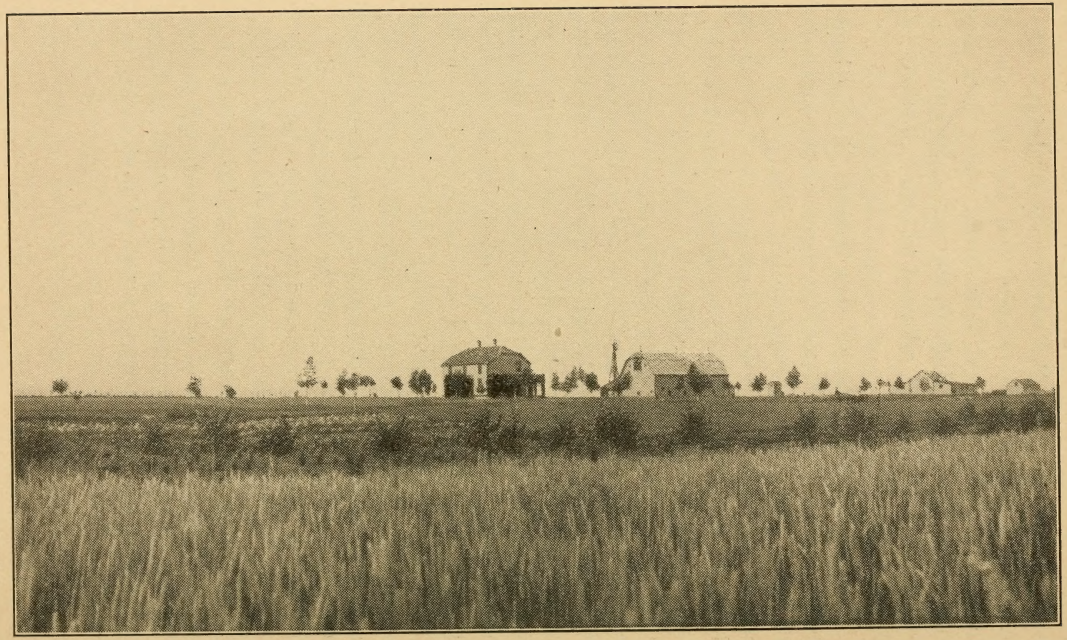


Fig. 1. A New North Dakota Farmstead.

CHAPTER I.

INDIAN CORN.

Early History. So far as known, Indian corn has never been found growing wild, but its native home was undoubtedly the semitropical portion of America. Columbus mentions having seen, in the New World, fields of maize (Indian corn) eighteen miles long. Cartier, in 1535, found Indian corn growing near the present site of Montreal. In 1603, Champlain found it growing east of the Kennebec river. The Indians of Massachusetts were producing it at the time of the landing of the Pilgrims, in 1620. Captain John Smith tells of its being produced in quantity by the Indians of Virginia. As so many early American explorers mention Indian corn, there can be no doubt that it was generally grown by the North American Indians all the way from Montreal to the Isthmus of Panama. It was also grown quite extensively by the Indians of South America. Corncobs and charred kernels are often found in prehistoric mounds, showing that Indian corn is a very old plant, and that it was produced in America many centuries before this continent was discovered by Europeans.

Later History. The early settlers of the United States found Indian corn an easy and profitable crop

to raise. As time passed, it gained in favor, and was grown more and more extensively, until today it is our greatest crop. The United States produces about three-fourths of the world's crop of corn. Austria-Hungary stands next in rank, while Indian corn is an important crop in Mexico, Argentine, Southern Russia, and Roumania. At present our greatest corn-producing states are Nebraska, Iowa, Kansas, Missouri, Illinois, Indiana, and Ohio. These states comprise what is commonly known as the "corn belt." Corn is also grown on a large scale in nearly all of the northern states. Early varieties are being produced, some of which ripen in the northern portions of Minnesota, North Dakota, and in Western Canada.

The Root. Being a true grass, no tap root is produced, but, instead, a system which branches out in all directions. Some of the roots grow downward, and often reach a depth of four feet or more, while others grow close to the surface. The corn plant obtains most of its water supply through its deep roots. This is especially true during very dry weather. When soil is well drained, the roots penetrate to a greater depth than in undrained soil, thus enabling the crop better to withstand drouth. Land that is not drained is often so wet during the spring that all the roots remain near the surface, and reach their growth without going deep. At earing time, when dry weather most frequently occurs, the roots cannot make much new growth, and thus cannot burrow downward to reach the moisture of the sub-

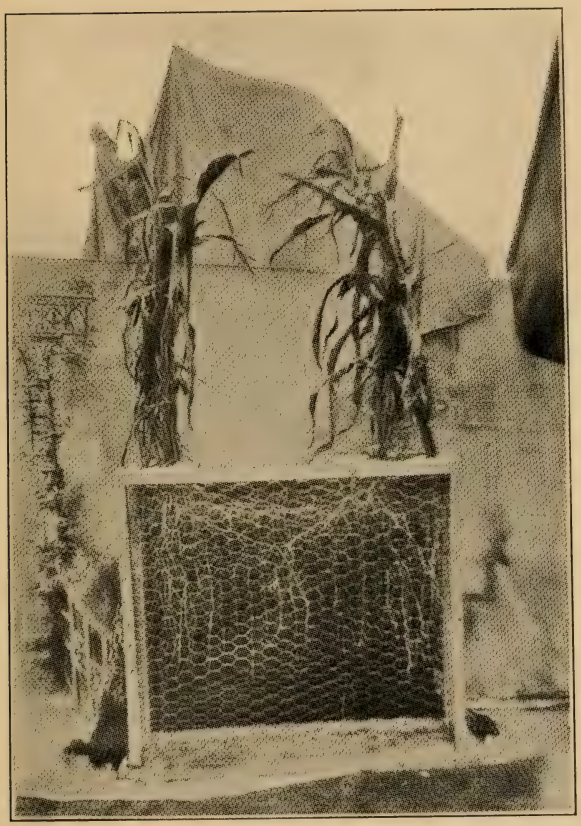


Fig. 2. Mature Corn Roots, from the Edgeley, N. D., Substation Farm.

soil. Deep cultivation late in the season usually causes a lighter yield by cutting off many roots that are growing near the surface to secure food and air. This weakens the plant and cuts off part of its supply of food at the time when it is most needed.

The Stem and Leaves. Under favorable conditions the stem or stalk grows very rapidly, and is usually quite tall when mature. The height of corn varies from eighteen inches to eighteen feet, according to the variety, kind of soil, and climate. When mature, the stem has a pithy center, and the outer portion is hard and woody. Each joint of the stem produces a leaf. Here again we see the likeness of corn to other grasses, as the leaf is a characteristic grass leaf, long and narrow, with the veins extending lengthwise. Cornstalks and leaves are valuable as roughage for feeding stock.

The Flower. The corn plant has two kinds of flowers—the male flower, or tassel, and the female flower, or silk. The tassel grows at the tip of the stem and is composed of many small flowers. Each of these produces a large amount of pollen for fertilizing the silks. The silks grow from the cob, there being one to each kernel. On windy days the pollen is scattered to quite a distance, making it easy for corn to cross-fertilize, therefore two varieties planted side by side are likely to mix. To obtain a cross between two varieties of corn the pollen of one variety is brought into contact with the silk of the other.

The Ear. The ear is the most valuable part of

the corn plant, and it has no superior for fattening stock. Sixty-three per cent. of the digestible matter of the corn plant is in the ear, and only thirty-seven per cent. in the stalk, blades, and husks. It requires seventy pounds of corn in the ear, or fifty-six pounds of shelled corn, to make a bushel.

The Kernel. The kernel of corn may be divided into five distinct parts: The tip cap, hull, corneous part, starchy part, and germ. The tip cap is a small cap that covers the inner or tip end of the kernel. Its office is to protect the germ, but it is sometimes broken off in shelling. The hull is the very thin outer coat of the kernel, and may be easily removed after soaking the kernel in water for a few minutes. The corneous part is yellow in color, rich in gluten, and is the most valuable part of the kernel. The white portion, which is rich in starch, nearly surrounds the germ. The germ is found in the center of the tip end, and extends from one-half to two-thirds the length of the kernel. The germ contains the embryo stem, pointing toward the crown of the kernel, and the embryo root, pointing toward the tip.

Plowing for Corn. The ground may be plowed either in the fall or spring with success. On the average, fall plowing produces somewhat larger yields of both fodder and ears; but the ground must be given thorough cultivation before planting, to prevent weeds from starting and to decrease evaporation.

Planting Corn. In warm, dry soils, corn should be planted deeper than in those that are cold and

heavy. The best results are usually obtained by planting from two to three inches deep. It seems advisable to plant the small varieties in hills about three and one-half feet apart each way, at the rate of four to six kernels to the hill. Growing corn in the manner described above leaves the soil in good condition for wheat or other small grain crops the following year. Sowed corn usually gives more pounds of feed per acre than corn planted in any other way, but it leaves the soil in poor condition for succeeding crops. Wait until the ground is quite warm before planting corn, as the seed may rot if planted in cold soil.

Cultivation. Corn should be harrowed after planting, and it is well to harrow after it is up. Cultivate often to make and preserve a soil mulch and to keep down weeds. Shallow cultivation gives the best results, as it forms a good soil mulch, does not injure the roots and allows them to come close to the surface for food and air. A corn cultivator should have small shovels.

Races of Corn. Indian corn may be divided into six groups or races: Pop corn, flint corn, dent corn, sugar or sweet corn, soft corn, and pod corn. Of these the dent and flint races are the ones grown generally as a field crop throughout the northern states.

(1) Dent Corn. The sides of the kernel consist of hard, translucent matter, and the center is filled with starch to the dent. The dent or dimple in the kernel is made by the shrinking of the soft starchy portion while the corn is ripening. In most varie-

ties of dent corn the kernels are slender and wedge-shaped.

(2) Flint Corn. As in dent corn, the central portion of the kernel is soft, white, and starchy, but there is a greater percentage of the outer flinty portion, which covers not only the sides, but also the crown of the kernel. There is no dent in the kernels, and they are usually as broad as long, and rounding and smooth over the crown.

(3) Sweet Corn. This is sometimes called "sugar corn." Excepting the germ, the kernels are of a clear, horny material throughout. This is not so hard as the flinty portion of the kernels of other races. The kernels have a considerable portion of the starch replaced by sugar. In most varieties of sweet corn the kernels, when ripe, are wrinkled and wedged-shaped.

(4) Pop Corn. This race is characterized by having small ears and very small kernels. In the best varieties the kernels are corneous throughout, and burst open when heated.

(5) Soft Corn. With the exception of the germ, the entire kernel is soft and starchy. In shape the kernels resemble those of flint corn. This race is grown quite extensively in the southwest, but does not mature in the northern states.

(6) Pod Corn. In pod corn, not only does the husk cover the ear, but each kernel is enclosed in a small husk. The kernels may be either dent or flint. At present, this race is of value only as a curiosity.

Varieties of Dent Corn. There are a great many varieties of dent corn, but few of them do well where the summers are short. If one were to name our leading northern varieties of dent corn in the order of their maturity, placing the earliest first, it would perhaps be correct to say: North Dakota No. 100, Golden Dent, Minnesota King, Northwestern Dent, and Pride of the North.

(1) North Dakota No. 100. North Dakota No. 100 is probably the earliest variety of dent corn. It is the result of a selection and breeding up from Minnesota King, and the description which follows for Minnesota King will apply very well to this variety.

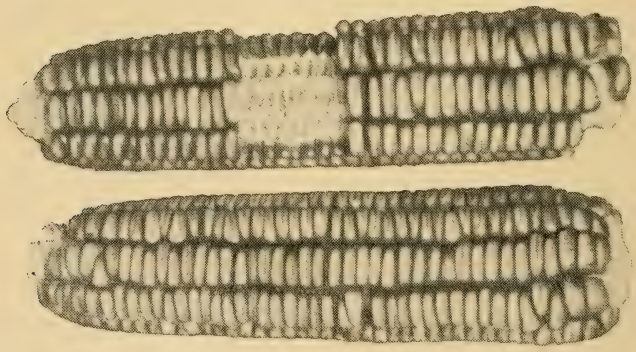


Fig. 3. Dent Corn—North Dakota No. 100.

North Dakota No. 100 is earlier than Minnesota King, and leans a little more toward its flint ancestry. The ears of North Dakota No. 100 are a little smaller and of a slightly deeper yellow color than those of Minnesota King.

(2) Golden Dent. This is one of the earliest va-

rieties of dent corn grown in the northwest. Seed of it has ripened in North Dakota for the past fifteen years. It is a good-yielding variety. The

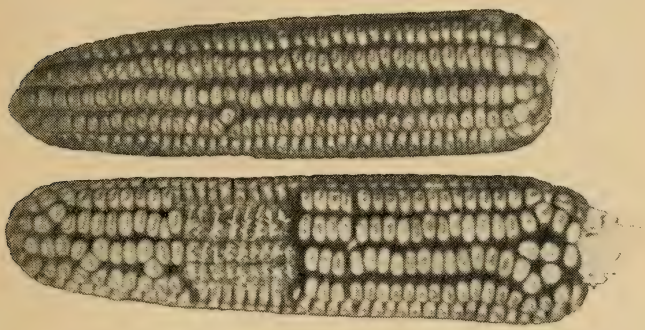


Fig. 4. Dent Corn—Golden Dent.

stalks grow from five to seven feet high, and, like all the other varieties of dent corn mentioned, the ears are high enough on the stalk for the corn to be cut readily with the corn binder. The ears are golden yellow in color, from five and a half to eight inches long, usually twelve to sixteen rowed, and particularly well filled at the butts. The cobs are red.

(3) Minnesota King. Minnesota King is a cross breed between dent and flint varieties. It yields well and is nearly as early as Golden Dent. The stalks are from five to seven feet high. The ears are from six to nine inches long, eight rowed, and have rather wide spaces between the rows. The kernels are wide, rather short for their width, and yellow in color. The cobs of this variety are white.

(4) Northwestern Dent. Northwestern Dent yields well, and will usually ripen in the southern

part of North Dakota. The stalks are from five to seven feet tall, and the ears are from fourteen to twenty-eight inches from the ground. The ears are

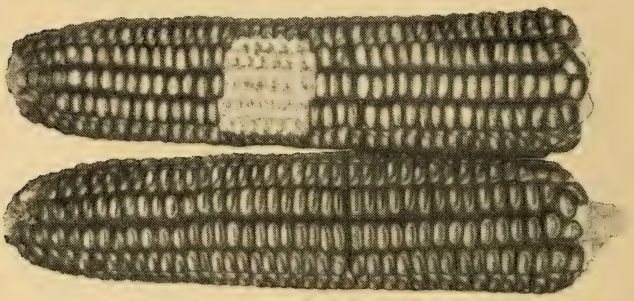


Fig. 5. Dent Corn—Northwestern Dent.

from six to nine inches long. The kernels have red sides and yellowish white crowns, and the cobs are white.

(5) Pride of the North. Pride of the North is a yellow dent, with ears from seven to ten inches

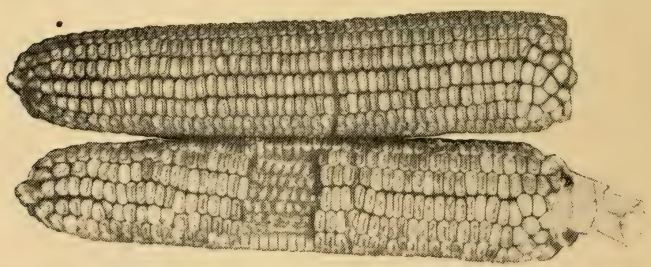


Fig. 6. Dent Corn—Pride of the North.

long, and ten to fourteen rowed. The kernels have a dull yellow color on the top of the crowns, which are deeply dented, and have a tendency to be shriv-

eled. The kernels are close, compact, and deep. They are rather thick for their width, and very tapering. Pride of the North has a large, red cob. It matures quite late, but otherwise is an excellent variety of corn.

Varieties of Flint Corn. Flint varieties are, on an average, smaller and earlier than the dent strains. They are generally harder to harvest by reason of having a large, strong shank attaching them to the stalk. As a rule, flint varieties have white cobs, regardless of the color of the kernels. Seven of the leading flint varieties of the northwest, and probably in the order of their earliness, are: Squaw corn, Will's Dakota, Gehu, Mercer, Triumph, Longfellow, and King Philip.

(1) Squaw Corn. Squaw Corn is a splendid yielding variety, and very early. The stalks are from four to five feet high. The ears of Squaw Corn, Will's Dakota, and Gehu are so low on the stalk that they are difficult to harvest with the corn binder. All the other varieties of flint corn mentioned have the ears high enough for the binder. The ears of Squaw Corn are from seven to ten inches long, and the kernels white, yellow, blue, and red.

(2) Will's Dakota. Will's Dakota is a white flint variety with ears seven to nine inches long, and usually eight rowed. The ears have a tendency to be large at the butt, and to taper abruptly towards the center. The kernels are large, and the cobs small and white. Will's Dakota was obtained by selecting and planting the white kernels of Squaw Corn.

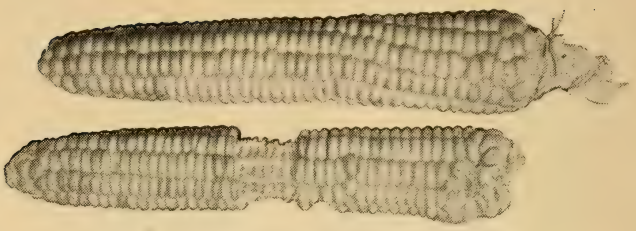


Fig. 7. Flint Corn—Will's Dakota.

(3) Gehu. Gehu is similar to Will's Dakota, except that the kernels are yellow. It was obtained by selecting and planting the yellow kernels of Squaw Corn.

(4) Mercer. Mercer flint is a good-yielding variety, and quite early. The stalks are from five to

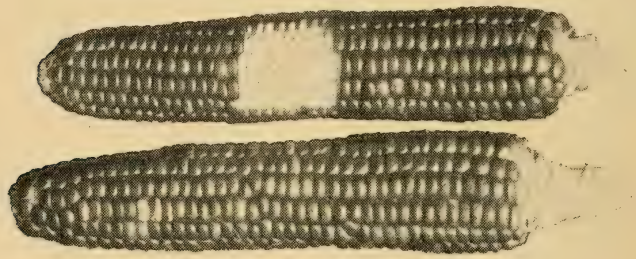


Fig. 8. Flint Corn—Mercer.

seven feet high, and the ears six to nine inches long, and yellow in color.

(5) Triumph. Triumph flint yields well, and is nearly as early as Mercer. The stalks are from five to six feet high. The ears are yellow, and from seven to ten inches long.

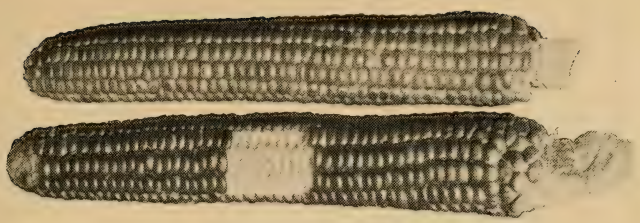


Fig. 9. Flint Corn—Triumph.

(6) Longfellow. Longfellow flint is a fairly good-yielding strain, but somewhat later than Triumph. The stalks are from five to seven feet tall, and the ears seven to ten inches long, and yellow in color.

(7) King Philip. King Philip is hardly early enough for any district in North Dakota. The stalks are from five to seven feet high. The ears are from

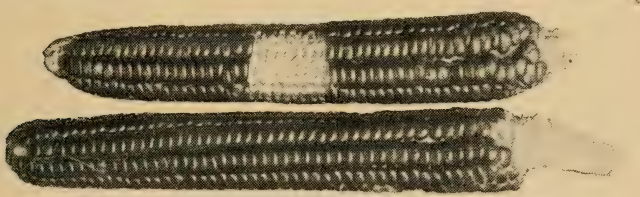


Fig. 10. Flint Corn—King Philip.

seven to ten inches long, eight rowed, and the kernels are copper colored. It is said that this was the variety of corn captured by the Puritans from the Indians during King Philip's War.

Selection of Seed Corn. After the corn is ripe, go into the field and select good ears from the best stalks, and save these for seed. The best does not always mean the largest. Select ears of the most desirable type. In the extreme northern part of the

United States, large corn usually fails to ripen. A good ear is true to type, well filled at the ends, ripe, has deep and reasonably uniform kernels, small spaces between the rows, and a small cob. By selecting only the ripe ears for seed, a variety may be made to mature earlier. The ears may be made to grow higher on the stalk by selecting seed from plants which carry the ears high. The corn grower may, by means of selection, bring about other changes also.

Relative Value of Butt, Center, and Tip Kernels. It seems to make little or no difference in the yield whether the seed is taken from the butt, center, or tip kernels. However, the tip and butt kernels are a little smaller than those from the middle of the ear, and will cause the planter to drop unevenly. For this reason the small butt and tip kernels should be rejected in shelling seed corn.

Preserving Seed. The best method for preserving seed corn is to dry it in the early fall by artificial heat. When seed corn is thoroughly cured it may be hung to the rafters of some dry building. This will insure its keeping dry, and prevent the ravages of mice. Do not store seed corn above grain bins or live stock, or in any other place where moist air will surround it.

Corn Judging. Corn is judged in much the same manner as live stock. Rules for judging and a scale of points have been worked out. Exhibits at a fair usually consist of ten ears each, but in school work a smaller number may be used. Select five ears of some variety of corn, and judge them according to the following score card:

SCORE CARD.

FIELD CORN.

SCALE OF POINTS.		NUMRER OF EXHIBIT.				
		1	2	3	4	5
1. Earliness: cob ripe, kernels hard, plump, bright colored	20.					
2. Type: uniform and true to variety characteristics	10.					
3. Shape of Ear: slightly tapering, nearly cylindrical, true to type	10.					
4. Color: conforming to variety, (a) kernel, (b) cob	5.					
5. Tips: not too tapering, well covered, kernels uniform	5.					
6. Butts: neither open nor swelled, shank small	5.					
7. Kernels: true to type, not tapering, rows straight	10.					
8. Length of Ear: medium for variety	10.					
9. Thickness of Ear: corresponding to variety	5.					
10. Rows Close: furrows in cob and space between kernels objectionable	10.					
11. Proportion of Corn on Ear: eighty-five per cent	10.					
Total	100					

Variety Judged.....

Name of Scorer.....

Date.....

EXPLANATION OF POINTS.

(1) Earliness. If the cob twists easily, the ear is not ripe. The kernels should not be shrunken or dull colored.

(2) Type. The ears of the sample should possess similar or like characteristics, and should be true to the variety which they represent.

(3) Shape of Ear. The shape of the ear should conform to variety type, tapering slightly from butt to tip, but approaching the cylindrical.

(4) Color. The color of the kernels should be true to variety, and free from mixture. White corn should have white cobs, and yellow corn red cobs, when the respective colors are characteristic of the variety under consideration. If the cob is off in color, a cut of one point shall be made, and for one or two mixed kernels, a cut of one point shall be made. Kernels missing from the ear shall be counted as mixed. Difference in shade of color, as light or dark, must be scored according to variety characteristics.

(5) Tips. The tips of the ears should not be too tapering, and should be well filled with regular, uniform kernels. Where the full diameter of the cob is exposed, a cut of one point shall be made.

(6) Butts. The rows of kernels should extend in regular order over the butt, leaving a deep impression when the shank is removed. Open and swelled butts are very objectionable.

(7) Kernels. The kernels should be tapering, uniform in shape, size, and color, and true to the

variety type. The tip portion of the kernel is rich in protein and oil, hence has the highest feeding value; for this reason the tip portion should be full and plump.

(8) Length of Ear. The deficiency and excess in length of all ears not conforming to the standard shall be added together, and, for every inch thus obtained, a cut of one point shall be made. Long ears are objectionable because they usually have poor butts and tips, and broad, shallow kernels, hence a low percentage of corn to cob.

(9) Thickness of Ear. In the northern section the circumference of the ear should be from 5 to 5½ inches. The deficiency and excess in circumference of all ears not conforming to the standard shall be added together, and for every two inches thus obtained, a cut of one point shall be made. Measure the circumference at one-third the distance from the butt to the tip of the ear.

(10) Rows Close. There should be no furrow in the cob, and space between the kernels near the cob is very objectionable.

(11) Proportion of Corn to Ear. In determining the proportion of corn to ear, weigh and shell every alternate ear in the exhibit. Weigh the cobs and subtract from weight of ears. This gives weight of corn. Divide the weight of corn by the total weight of ears to get the per cent. of corn. For each per cent. short of standard, a cut of one point shall be made.

On the Minnesota market shelled corn is graded as follows:

MINNESOTA COMMERCIAL CORN GRADES.*

No. 1 Yellow Corn. No. 1 Yellow Corn shall be sound, yellow, dry, plump, and well cleaned.

No. 2 Yellow Corn. No. 2 Yellow Corn shall be three-fourths yellow, dry, reasonably clean, but not plump enough for No. 1.

No. 3 Yellow Corn. No. 3 Yellow Corn shall be three-fourths yellow, reasonably dry, reasonably clean, but not sufficiently sound for No. 2.

No. 1 White Corn. No. 1 White Corn shall be sound, dry, plump, and well cleaned.

No. 2 White Corn. No. 2 White Corn shall be seven-eighths white, dry, and reasonably clean, but not plump enough for No. 1.

No. 3 White Corn. No. 3 White Corn shall be seven-eighths white corn, reasonably dry, and reasonably clean, but not sufficiently sound for No. 2.

No. 1 Corn. No. 1 Corn shall be mixed corn of choice quality, sound, dry, and well cleaned.

No. 2 Corn. No. 2 Corn shall be mixed corn, dry, reasonably clean, but not good enough for No. 1.

No. 3 Corn. No. 3 Corn shall be mixed corn, reasonably dry, and reasonably clean, but not sufficiently sound for No. 2.

No. 4 Corn. No. 4 Corn shall include all corn not wet and not in heating condition that is unfit for No. 3.

Note. No grain shall in any case be graded above that of the poorest quality found in that lot when it bears evidence of being plugged or doctored.

*Established by the Joint Board of Grain Appeals, August 31, 1904.

CHAPTER II.

WHEAT.

History. Wheat has been cultivated for so long a time that history fails to record the facts relative to its domestication. It originated in the Old World, and was grown in Egypt more than five thousand years ago. The wild plant from which it was derived is not positively known, although a low-bearded grass called "wild wheat" is found in the southern part of Europe. Kernels of wheat have been found in the tombs of Egypt. Such kernels are thousands of years old, and the stories of their growing when planted are idle tales, as no seeds can retain their vitality for so long a time.

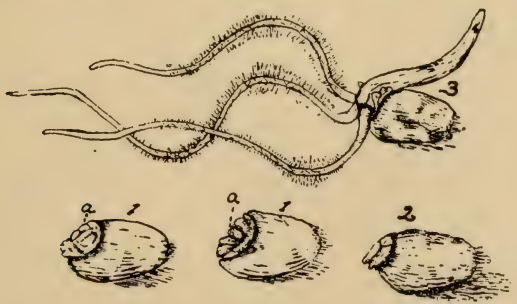


Fig. 11. Grains of Wheat. These separate figures represent the various stages in the sprouting of a normal wheat grain. No. 1 shows the appearance of the dry grain. No. 2 shows that the young plant or embryo in the seed end has swelled after one day in the germinator. No. 3 shows a good type of germination after three days' growth in the seed pan, showing the young stem and rootlets with root hairs. Drawn by H. L. Bolley.

The Root. The kernel of wheat germinates by sending out one stem, and usually three roots. Being a member of the grass family, wheat has no tap root. Many fine roots are soon sent out into the soil in all directions, and some of these may reach a depth of four feet, when the plant is ripe.

The Stem. Under favorable conditions the stem tillers or stools freely. The stooling or branching takes place close to the ground, and sometimes several stems or culms are sent up. Cool, moist weather and rich soil furnish ideal conditions for stooling.

The Flower. The head, when it first appears, contains many flowers. Each flower has three stamens and one pistil. After receiving the pollen from the stamens, the pistil produces the kernel. As both parts of the flower are enclosed in the chaff, the pollen dust of one blossom seldom comes in contact with the pistil of another flower, consequently varieties of wheat rarely cross fertilize.

Climate and Soil. Wheat is successfully grown all the way from the tropical regions to the Arctic Circle. Winter wheat and the soft varieties of spring wheat are grown extensively in the central and southern parts of the United States, while the hard varieties are mostly found in the northern and western states and in Canada. Durum or macaroni wheat withstands drouth better than most varieties, and produces a fairly good crop in ordinary years, even in the semiarid regions of the west.

Quantity of Seed Wheat Per Acre. Results of

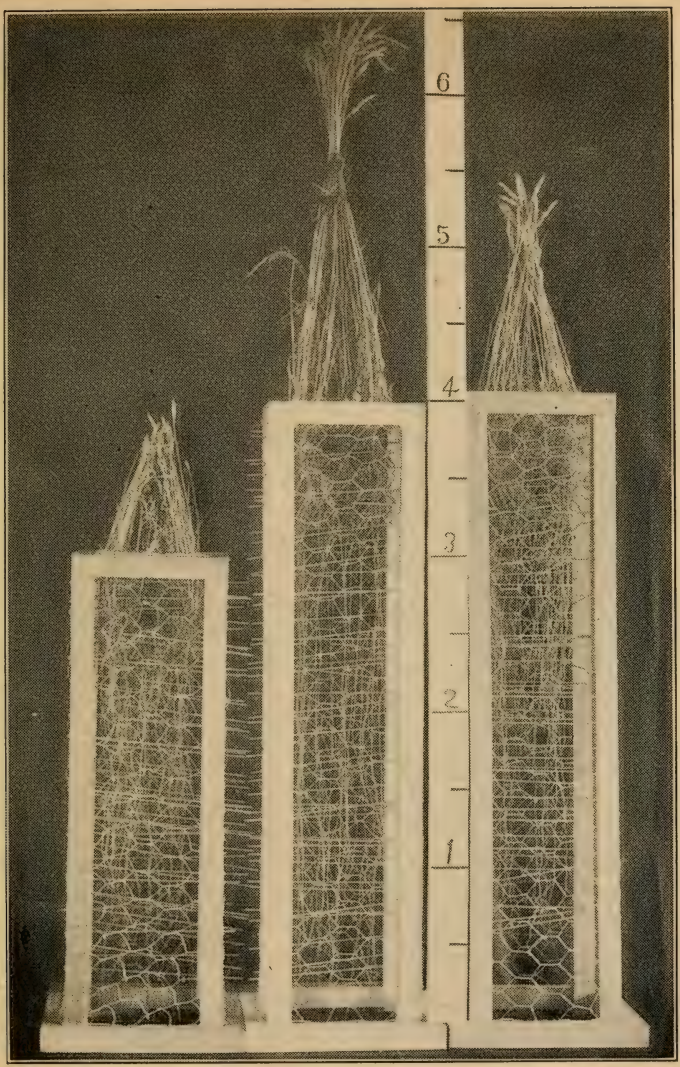


Fig. 12. Root Growths of Wheat. The samples on the left and right of the picture grew on land which had produced wheat continuously for many years, and show the extremes of growth for the very dry season of 1900. The middle sample is wheat grown upon land which produced corn the previous season. The illustration shows the natural root growth of wheat in the field, and that the stem growth and yield were more restricted by the drouth than was the root development.

seeding wheat at different rates per acre vary widely with the season. If the soil is moist at stooling time, three pecks per acre may yield as well as six would do were the soil dry at this time. Light soils require heavier seeding than do reasonably heavy ones. At the North Dakota Experiment Station, five pecks of seed per acre has, up to the present time (1905), given the best results for Fife and Blue Stem. A bushel of wheat weighs sixty pounds.

Preparation of Seed Bed. Fall plowing for wheat is preferred in most sections of the northwest. It conserves the moisture that is deep in the soil at the time of plowing, and allows it to take up more water from the melting snow in the spring. Ground plowed in the fall, which has become hard, should be cultivated with a disc harrow or some other implement in the spring before the grain is sowed. Corn ground seldom requires plowing for wheat, but should be cultivated until a good seed bed is formed.

Wheat Rust. Wheat rust is a common and injurious disease of wheat. It consists of a very small fungous plant, which grows inside the wheat plant. Warm, moist weather is favorable for the development of rust. The rust plant lives on the juices of the wheat culm, and weakens the stalk, which causes it to produce kernels that are more or less shrunken. When the rust plant becomes mature, it produces patches of red spores or rust seeds on the surface of the wheat leaf or stem, and, later in the season, similar patches of black spores appear. It is really

all one kind of rust in different stages of development. The spores reproduce the rust plant just as kernels of wheat do the wheat plant. The wind carries the spores from plant to plant, and in this way quickly spreads the disease. There is no treatment known which will prevent rust.

Smut. Smut is another fungus which grows in the wheat plant. There are two kinds,—loose smut and stinking smut. Loose smut is carried from plant to plant by the wind, and no successful method of treatment for it is known. Stinking smut forms the smut balls found in wheat. Smut in wheat reduces the yield and lowers the grade. Stinking smut can be prevented by treatment with formaldehyde. One pint of forty per cent. formaldehyde is mixed with forty-five gallons of water, the liquid is sprinkled over a pile of grain, and the grain is shoveled until all the kernels are moist. Each bushel of grain will take up about three-fourths of a gallon of the liquid. The grain will be dry enough to sow the following day. Seed wheat may be dipped in the formaldehyde solution, but the method is slow, less economic in the amount of solution required, and no more effective.

Classification. Wheat may be classified as hard and soft, spring and winter, bearded and smooth, macaroni or durum and bread wheat. Among the most successful varieties of wheat grown in the northwest are Scotch Fife, Blue Stem, and certain macaroni varieties. Scotch Fife and Blue Stem are

varieties of hard wheat. Macaroni, Fife, and Blue Stem are all spring wheats.

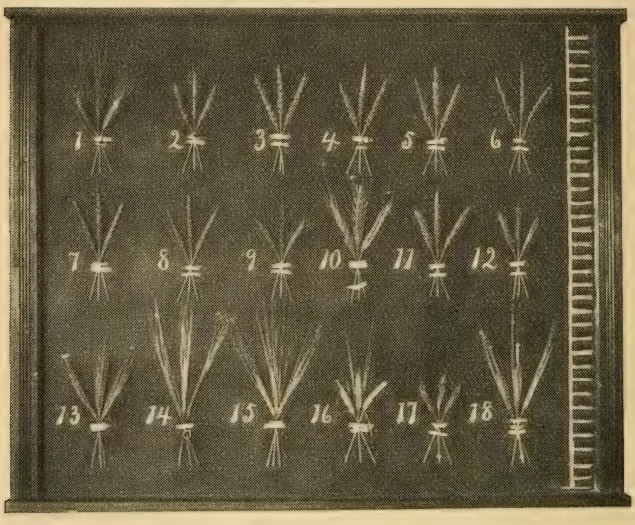


Fig. 13.

TYPES OF WHEAT AND BARLEY HEADS.

1. North Dakota No. 223, Kubanka (Durum) Wheat.
2. North Dakota No. 197, Preston Wheat.
3. North Dakota No. 236, Wellman's Fife Wheat.
4. North Dakota No. 146, Bolton's Blue Stem Wheat.
5. North Dakota No. 215, Rysting's Fife Wheat.
6. North Dakota No. 212, Glyndon 211 Fife Wheat.
7. North Dakota No. 149, White Russian Wheat.
8. North Dakota No. 66, Experiment Station Wheat.
9. North Dakota No. 194, Advance Wheat.
10. North Dakota No. 182, Polish Wheat.
11. North Dakota No. 221, Defiance Wheat.
12. North Dakota No. 246, Spring Club Wheat.
13. North Dakota No. 25, Mandschuri Barley.
14. North Dakota No. 27, French Chevalier Barley.
15. North Dakota No. 19, Success Barley.
16. North Dakota No. 7, Two-Rowed Mansury Barley.
17. North Dakota No. 23, Dakota Silver Beardless Barley.
18. North Dakota No. 21, White Hulless Barley.

(1) Hard Wheat. The term "hard wheat" is a trade name which means wheat that is rich in

gluten of good quality. Scotch Fife and Blue Stem are classed as hard wheat on account of the quality and quantity of gluten which they contain. Hard wheat is more in demand among millers, because it makes a lighter colored flour and more elastic dough than soft wheat. The gluten holds the particles of bran together, so that they are easily separated from the flour, leaving it nearly pure white in color. In soft wheat the bran is brittle, breaks up in grinding, and, as a consequence, becomes more or less mixed with the flour, to which it imparts a dark color.

(2) Winter Wheat. Winter wheat is not commonly successful in western Minnesota and the Dakotas. The snowfall is light in this region, and, during the average winter, wheat is not sufficiently protected to keep it from killing out.

(3) Scotch Fife. It is supposed that Fife wheat came to this country from Canada, to Canada from Scotland, and to Scotland from the interior cold region of Russia. The kernel is brown or reddish brown in color, and contains a large percentage of gluten. No variety of wheat grades higher than the better strains of Scotch Fife.

(4) Blue Stem or Spring Velvet Chaff. This taller, strong growing variety is the only real competitor of Fife wheat in this country. The chaff is covered with a hairlike growth, from which it gets the name of Velvet Chaff. The average for eight years' trial at the North Dakota Station gives Blue Stem wheat nine-tenths of a bushel more grain per acre than Fife, but Fife wheat averaged nearly one

grade better than the Blue Stem strain. Blue Stem wheat is five or six days later than the Fife in maturing. The berry is not quite so red, and is a little larger. Blue Stem cannot be allowed to stand so long in the field after ripening as Fife, because it bleaches and shells more readily.

(5) Durum, Macaroni, or Flint Wheat. Macaroni wheat is used largely for making macaroni instead of flour, although during the past two years it has gained much in favor as a bread wheat. It was recently introduced into this country from Russia, and it seems to be well suited to the Dakotas. The heads are bearded, and the kernels long and very light in color compared with the kernels of the Fife and Blue Stem varieties. In trials at the North Dakota Station covering six years—1899 to 1904, inclusive—the average yield from Macaroni wheat was about four bushels per acre greater than that from the Fife and Blue Stem varieties. A good quality of bread can be made from Macaroni wheat flour, but it is slightly dark in color. Macaroni wheat is flinty, but on account of the nature of its gluten it is not classed among the hard varieties.

Mixing Varieties. Varieties of bread and macaroni wheat should never be mixed, as this makes it difficult for the miller to manufacture good flour. If these varieties are mixed, the price paid to the farmer is lower.

Importing Seed Wheat. It has been demonstrated many times at the Experiment Station that, where the climate and soil are especially adapted to

Fig. 14. Macaroni Wheat.

wheat growing, usually nothing is gained by importing seed wheat. The North Dakota Station, in a series of twenty-three tests with home-grown seed, and with the same strain of wheat originally grown at this Station, but grown at the Minnesota Station for periods of from one to nine years, found an average gain of two and one-half bushels per acre in favor of the home-grown seed. Farmers living in

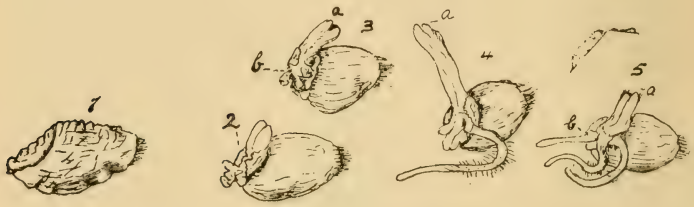


Fig. 15. Grains of Wheat. Partially injured by bad conditions in the bin or in the field, show the effect in the first growth from the seed. In the case of bin burning and freezing and thawing, there are always very characteristic effects. This figure shows various injuries to the rootlets and stems of the young plants, due to freezing and thawing in the shock.

the great wheat region of the northwest will, as a rule, gain little, and will often lose, by importing seed from the eastern or southern states. Care should be taken, however, to grade the seed wheat carefully, and to sow nothing but the best that can be procured.

Wheat Judging. Several samples of wheat should be procured and judged according to the following score card:

NORTH DAKOTA AGRICULTURAL COLLEGE.

DEPARTMENT OF AGRICULTURE.

STUDENTS' SCORE CARD NO. 8.

WHEAT.

1.	Uniformity: even in size, similar in shape	10.
2.	Color: clear, bright, uniform, corresponding to variety type	10.
3.	Bran: bright, smooth, free from cracks, streaks, and bleaching	10.
4.	Size and plumpness of kernels: long, thick, and heavy	25.
5.	Weight: standard sixty pounds per bushel	10.
6.	Dockage: per cent. and nature, weight and kinds of dirt, weed seeds and very small kernels	15.
7.	Per cent. and kinds of damaged kernels: broken, smutty, musty, or bin-burned	20.
	Total	100.

Variety judged .....

Name of student .....

Date .....

EXPLANATION OF POINTS.

(1) Uniformity in Shape and Size. The kernels in the sample should all be similar in shape and be practically of the same size to secure the full mark.

(2) Color of Grain and Freedom from Mixture. This has reference to the bright, clear color of the kernel, and also refers to the per cent. of kernels which are of the general color of the class which is being scored.

(3) Condition of Bran—Cracked, Weathered or Streaked. This is determined by the inspection of kernels in a unit sample. If cracked or weathered, the vitality of the kernel is liable to injury, and, if spotted or mottled, the market rating of the wheat is reduced. All three affect the commercial rating.

(4) Size and Plumpness of Kernels. The size may be determined by weighing one hundred average kernels of the particular sample, and by finding the length of ten average kernels laid end to end. The plumpness of the grain may be found by the inspection of kernels in a unit sample.

(5) Weight of Grain. Wheat should weigh at least sixty pounds to the measured bushel, which we use as a standard. The relative weight is indicated by the chondrometer samples of the wheat being scored.

(6) Per Cent. and Nature of Weed Seed, Dirt, and Other Foreign Material. This is to be determined by weight of dirt, weed seed, etc., found in a unit sample, as, for example, one-half pound.

Fig. 16. Drawing from a photograph, showing difference in results obtained from different grades of seed wheat. No. 30 was from seed which was frosted when immature. No. 40½ grew from No. 1 hard wheat of same breed as Nos. 30 and 36. No. 36 grew from seed which had been damp in the stack. The bundle in each case shows the amount of grain which grew upon one rod of a drill row.

(7) Per Cent. of Damaged, Smutty, or Musty Grain. This is obtained by counting out five hundred to one thousand kernels and noting the number damaged.

Grading Wheat. The Minnesota grades given below are followed quite closely in grading wheat throughout the northwest. These grades were adopted August 31, 1904, by the Minnesota Board of Grain Appeals.

MINNESOTA GRADES.

No. 1 Hard Spring Wheat. No. 1 Hard Spring Wheat must be sound, bright, and well cleaned, and must be composed mostly of hard Scotch Fife, and weigh not less than fifty-eight pounds to the measured bushel.

No. 1 Northern Spring Wheat. No. 1 Northern Spring Wheat must be sound and well cleaned. It may be composed of the hard and soft varieties of spring wheat, but must contain a larger proportion of the hard varieties, and weigh not less than fifty-seven pounds to the measured bushel.

No. 2 Northern Spring Wheat. No. 2 Northern Spring Wheat must be sound and reasonably clean; this grade to include all wheat not suitable for the higher grades on account of smut, barley, or too much king heads, cockle, and oats, or any other defects, or contain not more than twenty-five per cent. of soft yellow wheat, and must weigh not less than fifty-six pounds to the measured bushel.

No. 3 Spring Wheat. No. 3 Spring Wheat shall

comprise all inferior, shrunken spring wheat, weighing not less than fifty-four pounds to the measured bushel.

No. 4 Spring Wheat. No. 4 Spring Wheat shall include all inferior spring wheat that is badly shrunken or damaged, and must weigh not less than forty-nine pounds to the measured bushel.

Note. Hard, flinty wheat, of good color, containing no appreciable admixture of soft wheat, may be admitted into the grades of No. 2 Northern Spring, No. 3 Spring Wheat, and No. 4 Spring Wheat, provided the test weight of the same is not more than one pound less than the minimum test weight required by the existing rules for said grades, and provided, further, that such wheat is in all other respects qualified for admission into such grades.

Rejected Spring Wheat. Rejected Spring Wheat shall include all spring wheat grown badly, bleached, or for any other cause unfit for No. 4 Wheat.

DURUM (MACARONI) WHEAT.

No. 1 Durum. No. 1 Durum shall be bright, sound, and well cleaned, and be composed of Durum, —commonly known as Macaroni Wheat.

No. 2 Durum. No. 2 Durum shall include wheat that is bleached and shrunken.

No. 3 Durum. No. 3 Durum shall include all wheat that is badly bleached, smutty, or for any other cause unfit for No. 2.

Rejected Durum. Rejected Durum Wheat shall include all wheat that is very smutty, badly bleached, and grown, or for any cause unfit for No. 3.

MIXED WHEAT.

In case of admixture of Durum, Western, Winter, or Western White and Red Wheat with Minne-

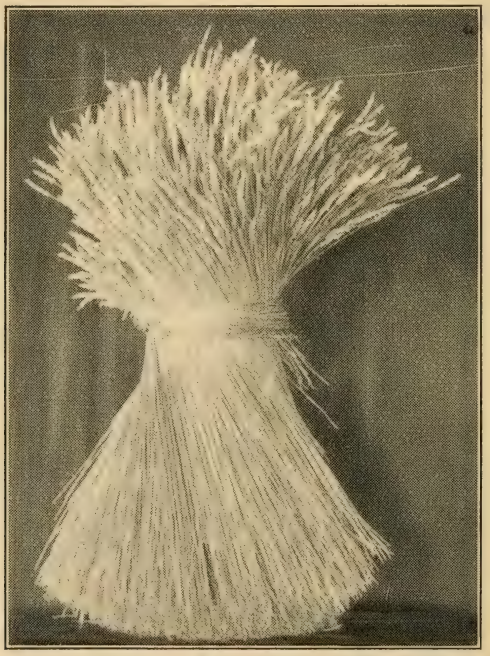


Fig. 17. No. 1 Sheaf of Fife Wheat.

sota Grades of Northern Spring Wheat, or with

each other, it shall be graded according to the quality thereof, and classed as No. 1, 2, 3, etc., Mixed Wheat, with inspector's notation describing its character.

Note. No grain shall in any case be graded above that of the poorest quality found in that lot, when it bears evidence of being plugged or doctored. This note applies to the grading of all kinds of grain.

CHAPTER III.

OATS.

History. Oats were not cultivated by the ancient Egyptians, Hebrews, Greeks, or Romans, but they were grown by the prehistoric inhabitants of Europe, and may have been cultivated for as long a time as wheat.

Manner of Growth. In well-drained soil, oat plants usually send their roots down to a depth of about four feet. Being a true grass, the oat plant produces no long tap root, but, instead, it sends branching ones in all directions. The stem or culm stools under favorable circumstances, and several stems are usually produced by a single seed. The kernels, unlike those of wheat and rye, retain their hulls when threshed.

Soil. On very rich, heavy soil, oats are almost sure to lodge. They do best on moist soil that is neither light nor very heavy, and comparatively rich in plant food.

Preparation of Seed Bed. Plowing may be done either in the fall or spring. Fall plowing is generally preferred, as it enables the grower to sow the seed earlier in the spring. Sowing early in the spring forces early cultivation of the soil, thus forming a surface mulch that conserves soil moisture.

If the oat crop follows some cultivated crop, like corn, it is not necessary to plow at all, unless the soil is very compact. If oats are sowed on fall-plowed land, or if they follow a cultivated crop, the soil should be loosened with a disc, spring-tooth, or acme harrow as early in the spring as the ground is in good condition.

Sowing. Sow about two and one-half bushels of seed to the acre. A less amount may do as well if the weather is favorable at stooling time. The depth of sowing may vary from two to four inches. When conditions are favorable, shallow seeding is best, but the seed should be placed deep enough to be in moist soil, unless this would require seeding to a greater depth than four inches. If oats are sown deeper than four inches, they will hardly be able to grow up through the soil above. Better results are generally obtained from sowing with the drill than from using a broadcast seeder, as the drill covers the seed to a more nearly uniform depth.

Cultivation. Oats may be cultivated with a light harrow just before coming up, and again when a few inches high. Such harrowing kills weeds, does not injure the oats, and maintains a soil mulch which decreases the evaporation of soil moisture.

Climate. Oats do best in cool, moist climates. They do fairly well in the south where the climate is warm and moist, but not so well where it is warm and dry. Oats degenerate rapidly when grown in a hot climate,—they do not yield as well nor weigh so much per measured bushel. By far the largest

per cent. of oats in the United States is produced in the northern states.

Diseases. Oats are often injured by rust and smut. There is at present no treatment for rust. Oat smut is of two kinds,—loose smut and covered smut. Both are prevented by the formaldehyde treatment. The treatment is the same as for wheat, but oats require from one and one-half to two gallons of the solution per bushel.

Uses. Oats are the best of all grain feeds for horses. They are a very satisfactory feed for other stock, and are usually not high in price. Oatmeal is widely used as a food for man, especially in Scotland and other European countries. Oatmeal is also used to quite an extent in America.

Varieties. There is no good classification for oats, and many of the varieties grown differ little except in name. They may be classified according to color, as white, black, and yellow; according to shape of heads, as side oats, and whorled or branching oats; according to hulls, as common and hulless; or they may be classified as spring and winter oats. White oats sell a little better on the market than either the black or yellow kinds. The yield is about equal for branching and side oats, while all of the common strains yield much better than the hulless variety. Winter oats cannot be grown successfully north of Tennessee and Kansas. Among the varieties that yield well in the northwest the following may be mentioned: White Russian, Sixty Day, Selected Tartarian, Silver Mine, and Big Four.

FIG. 18. TYPES OF OATS, EMMER AND MILLET.

No. 1. North Dakota No. 2, Archangel Oats.
No. 2. North Dakota No. 46, Black Beauty Oats.
No. 3. North Dakota No. 60, White Wonder Oats.
No. 4. North Dakota No. 45, Silver Mine Oats.
No. 5. North Dakota No. 64, Negro Wonder Oats.
No. 6. North Dakota No. 53, Great Northern Oats.
No. 7. North Dakota No. 2, Emmer.
No. 8. North Dakota No. 6, Hungarian Grass.
No. 9. North Dakota No. 9, Common Millet.
No. 10. North Dakota No. 14, Siberian Millet.
No. 11. North Dakota No. 21, German Millet.
No. 12. North Dakota No. 16, Red Voronesh Millet. (U. S. No. 2,796.)
No. 13. North Dakota No. 12, Broom Corn or Hog Millet.
No. 14. North Dakota No. 15, Tambor Millet. (U. S. No. 2,794.)

NORTH DAKOTA AGRICULTURAL COLLEGE.

DEPARTMENT OF AGRICULTURE.

STUDENTS' SCORE CARD NO. 9.

OATS.

SCALE OF POINTS.		NUMBER OF EXHIBIT.				
		1	2	3	4	5
1. Uniformity: even in size, similar in shape	10.					
2. Color: bright, uniform, corresponding to variety type, free from weather stains	15.					
3. Size and Plumpness: long, thick, plump, corresponding to variety in size and shape	15.					
4. Weight: standard 32 lbs. per bushel	10.					
5. Feeding Quality: per cent of husk to kernel, of empty husks, of pin oats	20.					
6. Dockage, Per Cent and Nature: weight and kinds of dirt, weed seeds and other grain	15.					
7. Per Cent and Kinds of Damaged Kernels: musty, moldy, bin-burned	15.					
Total	100					

Variety Judged.....

Name of Student.....

Date.....

MINNESOTA GRADES.*

No. 1 White Oats. No. 1 White Oats shall be white, dry, sweet, sound, clean, and free from other grain, and shall weigh not less than thirty-two pounds to the measured bushel.

No. 2 White Oats. No. 2 White Oats shall be seven-eighths white, dry, sweet, sound, reasonably clean, and practically free from other grain, and shall weigh not less than thirty-one pounds to the measured bushel.

No. 3 White Oats. No. 3 White Oats shall be seven-eighths white, dry, sweet, sound, reasonably clean, and practically free from other grain, and shall weigh not less than twenty-nine pounds to the measured bushel.

No. 4 White Oats. No. 4 White Oats shall be seven-eighths white, but not sufficiently sound and clean for No. 3 White, and shall weigh not less than twenty-five pounds to the measured bushel.

Yellow Oats. The grades of Nos. 1, 2, and 3 Yellow Oats shall correspond with the grades of Nos. 1, 2, and 3 White Oats, excepting that they shall be of the yellow varieties.

No. 1 Oats. No. 1 Oats shall be dry, sweet, sound, clean, and free from other grain, and shall weigh not less than thirty-two pounds to the measured bushel.

No. 2 Oats. No. 2 Oats shall be dry, sweet, sound, reasonably clean, and practically free from

*Established by the Joint Board of Grain Appeals, August 31, 1904.

other grain, and shall weigh not less than thirty-one pounds to the measured bushel.

No. 3 Oats. No. 3 Oats shall be all oats that are merchantable and warehouseable, reasonably clean, and not fit for the higher grades.

No. 1 Clipped White Oats. No. 1 Clipped White Oats shall be white, dry, sweet, sound, clean, and free from other grain, and shall weigh not less than forty pounds to the measured bushel.

No. 2 Clipped Oats. No. 2 Clipped Oats shall be seven-eighths white, dry, sweet, sound, reasonably clean, and practically free from other grain, and shall weigh not less than thirty-eight pounds to the measured bushel.

No. 3 Clipped White Oats. No. 3 Clipped White Oats shall be seven-eighths white, dry, sweet, sound, reasonably clean, and practically free from other grain, and shall weigh not less than thirty-six pounds to the measured bushel.

Note. No grain shall in any case be graded above that of the poorest quality found in that lot, when it bears evidence of being plugged or doctored.

CHAPTER IV.

BARLEY.

History. Barley has been cultivated since prehistoric times. The ancient Egyptians and Romans cultivated barley, and among the writings of the Romans are found explicit directions for its best culture and production. Barley was the chief bread crop of Europe previous to the sixteenth century. At the present time it is one of the most widely distributed of cultivated plants. It is a common crop in the northern part of the United States and in western Canada. Barley is also grown extensively along the Pacific coast.

Manner of Growth. Barley belongs to the grass family. The roots are spreading, and grow to a depth of about four feet, although it obtains most of its nourishment from the surface soil. The varieties most commonly grown have hulls which cling closely to the kernels. A long, barbed awn or beard usually grows on the hull. There are strains which, like wheat, lose their hulls in threshing. These are called hulless varieties.

Climate. Barley is successfully grown in all climates, from Iceland and Norway to southern California. It does fairly well in a dry, hot climate. The young plants are easily damaged by cold, yet

the seed will sprout and grow with the ground frozen only a few inches below the roots. During ten years of experimental work with barley at the North Dakota Station, the shortest period of maturity was seventy-one days and the longest ninety-nine days.

Soil. Barley needs a fertile soil, and is not likely to lodge even when the soil has been liberally enriched.

Culture. The soil should be well drained and well prepared. Deep plowing is best. It is much better to manure land for the previous crop than to have barley follow it direct, especially when heavy applications are made. Barley is more sensitive than wheat to cold, hence it should not be sown quite so early. Sow at the rate of two to two and a half bushels per acre. Each seed may produce several culms or stems. Use only the largest seed which can be secured by careful screening. The Tennessee Station found the average yield, in a series of five years, to be ten and three-fifths bushels per acre in favor of large seed. It is a better weed fighter than wheat or oats, as it makes a very heavy growth of stems, and ripens earlier.

Uses. A limited amount of barley is used in this country for making breakfast foods, gruels, and soups. In some European countries it is very generally used as human food. Its chief use in America, however, is in the manufacture of beer, and for feeding animals. For making beer it must be clean, bright, plump, and well matured. As a stock feed it ranks high.

NORTH DAKOTA AGRICULTURAL COLLEGE.

DEPARTMENT OF AGRICULTURE.

STUDENTS' SCORE CARD NO. 10.

BARLEY.

SCALE OF POINTS.		NUMBER OF EXHIBIT.				
		1	2	3	4	5
1. Uniformity: even in size, similar in shape	15.					
2. Color: bright, free from stains and weathering	30.					
3. Size and Plumpness: long, thick, plump, corresponding to variety in size and shape	15.					
4. Weight: standard 48 lbs. per bushel	15.					
5. Per Cent and Kind of Damaged Kernels: musty, moldy, or bin-burned	15.					
6. Dockage, Per Cent, and Nature: dirt, weed seeds, and foreign grain	10.					
Total	100					

Variety Judged.....

Name of Student.....

Date.....

Classification. Barley may be classed as two-rowed, four-rowed and six-rowed. It is also classified as white hulless, black hulless, bearded, and beardless. The following are some of the most common varieties: Mansury, Chevalier, Highland Chief, Carter, White Hulless, and Black Hulless.

Grading: Grade samples of barley according to the following rules:

MINNESOTA GRADES.*

No. 1 Barley. No. 1 Barley shall be plump, bright, clean, and free from other grain, and shall weigh not less than forty-eight pounds to the measured bushel.

No. 2 Barley. No. 2 Barley shall be sound and of healthy color, not plump enough for No. 1, reasonably clean, and reasonably free from other grain, and shall weigh not less than forty-six pounds to the measured bushel.

No. 3 Barley. No. 3 Barley shall include all slightly shrunken and otherwise slightly damaged barley, not good enough for No. 2, and shall weigh not less than forty-four pounds to the measured bushel.

No. 4 Barley. No. 4 Barley shall include all barley fit for malting purposes, not good enough for No. 3.

*Established by the Joint Board of Grain Appeals, August 31, 1904.

No. 1 Feed Barley. No. 1 Feed Barley must test not less than forty pounds to the measured bushel, must be sweet and reasonably sound.

No. 2 Feed Barley. No. 2 Feed Barley shall include all barley which is for any cause unfit for malting purposes. It may include a liberal sprinkling of wheat, rye, wild oats, and seeds.

Chevalier Barley. Nos. 1, 2, and 3 Chevalier Barley shall conform in all respects to the grades of Nos. 1, 2, and 3 Barley, except that they shall be of a Chevalier variety, grown in Montana, Oregon, and on the Pacific coast.

No Grade. All Wheat, Barley, Oats, Rye, and Corn that are in a heating condition, too musty or too damp to be safe for warehousing, or that are badly bin-burnt, badly damaged, exceedingly dirty, or otherwise unfit for storage, shall be classed as no grade, with inspector's notation as to quality and condition.

Note. No grain shall in any case be graded above that of the poorest quality found in that lot, when it bears evidence of being plugged or doctored.

CHAPTER V.

RYE.

History. Rye is supposed to have been cultivated first in the northeastern part of Europe. It was not grown by the ancient Egyptians or Greeks, and was probably not introduced into the Roman Empire until the beginning of the Christian era.

Manner of Growth. When the kernel of rye germinates, it sends out four temporary roots. Rye grows taller, and the heads are somewhat longer, than those of wheat.

Climate. Rye is very hardy, and is not nearly so likely to winter kill as winter wheat. In spite of its hardy character, it often winter kills in the Dakotas on account of the scanty protection afforded by the usually light snowfall. Some success has been attained in the attempt to produce a hardy strain that will withstand the winters of the northwest.

Soil. Rye is especially adapted to a light soil. In this respect it is a rival of buckwheat. Because rye grows so vigorously on comparatively light land, it is very valuable for green manuring.

Sowing. In North Dakota, winter rye should be sown about the middle of August. Sow from one and one-half to two bushels of seed to the acre.

Varieties. Rye is divided into two classes,—spring and winter. Winter rye is grown much more extensively in the United States than spring rye. So far, neither has done well in trials at the North Dakota Experiment Station. Spring rye has given light yields, due largely to a lack of stooling; and winter rye, because of a lack of snow covering, has usually winter killed to such an extent as to make its production unprofitable.

Uses. The grain is used to produce flour, as food for live stock, and for the production of alcohol. Rye straw is used extensively in the manufacture of paper, baskets, boxes, mats, etc.

Diseases. Rye is sometimes attacked by rust and smut, but its greatest enemy is ergot. Ergot is easily recognized by the appearance of the kernels affected. Such kernels are very large, and much changed in color and composition. Rye containing ergot is injurious to live stock.

MINNESOTA GRADES.

No. 1 Rye. No. 1 Rye shall be sound, plump, and well cleaned, and shall weigh not less than fifty-five pounds to the measured bushel.

No. 2 Rye. No. 2 Rye shall be sound, reasonably clean, and reasonably free from other grain, and shall weigh not less than fifty-two pounds to the measured bushel.

No. 3 Rye. All Rye slightly damaged, slightly musty, or from any other cause unfit for No. 2, shall be graded as No. 3.

Note. No grain shall in any case be graded above that of the poorest quality found in that lot, when it bears evidence of being plugged or doctored.

CHAPTER VI.

EMMER.

In this country, emmer is commonly but erroneously called "spelt." Emmer, like wheat, has been grown for thousands of years. It seems to have been introduced into this country from Russia. Emmer is well adapted to districts which are too dry for the most successful wheat growing. The results of seven years' trial at the North Dakota Experiment Station (1898 to 1904, inclusive) show the following average yield in pounds per acre from emmer, barley, oats, and wheat:

Emmer or spelt yielded.....2096 lbs. per acre.
Barley yielded .....2025 lbs. per acre.
Oats yielded .....2035 lbs. per acre.
Wheat yielded .....1733 lbs. per acre.

Emmer is closely related to the common varieties of wheat. When threshed, its husks adhere to the kernel. This gives the grain a little the appearance of barley.

CHAPTER VII.

FLAX.

History. The ancient Egyptians and Hebrews produced flax, and made linen cloth of the fiber. Linen wrappings are found on the Egyptian mummies. During the past hundred years, cotton cloth has largely displaced linen. Flax is grown extensively in Russia, Germany, Netherlands, Ireland, and the United States.

Manner of Growth. Flax generally grows to a height of from two to three feet. Blue or white flowers are produced in clusters at the end of the branches. Each seed produces a single stem, which may branch extensively. When sown thin, each plant produces many branches and a large amount of seed. When sown very thick, flax grows much taller, and the branches are produced near the top only. Thick seeding decreases the yield of seed, but improves the quality of the fiber.

Climate and Soil. Flax succeeds in about as great a range of climate as wheat. It does best where rains are frequent. It is a very common practice to grow flax on new land, but any soil that is adapted to other cereal crops will produce flax. It does better on a sandy loam than on a clay loam. For a long time, flax has had the reputation of be-

ing hard on the land. Investigators have recently proven that flax is no harder on soil than is wheat or oats. Probably the reason that flax has the reputation of injuring the soil is because of a disease now known as flax wilt. If this disease gets into the soil, succeeding crops of flax are sure to be injured, and sometimes entirely destroyed. A crop of flax takes practically the same amount of plant food from the soil that a crop of wheat requires.

Fig. 19. A Heavy Seed Yielding Flax Plant.

Seeding. Prepare the seed bed as for wheat, but have it smooth. The seeds of flax are much smaller than wheat kernels, and in consequence may be covered too deep on a rough seed bed. If the crop is grown for seed, sow at the rate of from two to three pecks per acre. When fiber is desired, sow a fiber strain, and a larger quantity of seed per acre. Flax should be covered one to three inches deep. It is usually sown later in the spring than other grain crops. This gives the weeds a good start, unless particular care has been taken to keep them down until the time of seeding. A bushel of flaxseed weighs fifty-six pounds.

Diseases. Flax wilt is common, and often destroys the crop. The disease is caused by wilt seeds or spores. Germs of the disease will live several years in the soil. At present, no treatment is known for soil that contains wilt spores. All that can be done is to stop growing flax on the infected soil for several years. By means of selection, a strain of flax has been developed at the North Dakota Experiment Station which will grow despite the disease.

Treatment of Flaxseed. Remove the light seeds and dirt, and apply the formaldehyde solution used in treating seed wheat for smut. Apply the solution slowly and evenly, and shovel the seed constantly to prevent matting. A small force pump with a nozzle set to throw a misty spray is best for the work. One-half gallon of the solution should be used per bushel of flax. Do not sow on old, diseased flax ground, but practice rotation of crops. Flax is not a good weed fighter, and in consequence should be sown on clean land. Care should be exercised in selecting flax for sowing to prevent weed seed from being included. Flaxseed on the market often contains false flax and mustard seed.

Uses. The fiber of the flax plant, when properly treated, is made into cloth known as "linen." The seed is sometimes used as a food for stock, but its greatest value is in the production of linseed oil. After the oil is extracted, the residue is used for feed, and is known as "oil meal."

Fig. 20. Flax Wilt. This cut illustrates the characteristic effects of the plant disease known as "flax wilt."

Fig. 21. This photograph shows the results of one of the first experiments in the production of immune strains of flax at the North Dakota Experiment Station. The flax is growing upon flax-sick soil. That on the left is the high bred immune flax, called No. 22. The samples on the right grew from various samples of seed collected in the market. In these cases practically all plants died before maturity.

MINNESOTA GRADES.*

All flaxseed inspected shall be classed, according to quality and conditions, as follows:

No. 1 Northwestern Flaxseed. Flaxseed, to grade No. 1 Northwestern, shall be mature, sound, dry, and sweet. It shall be northern grown. The maximum quantity of field, stack, storage, or other damaged seed intermixed shall not exceed twelve and one-half per cent. The minimum weight shall be fifty-one pounds to the measured bushel of commercially pure seed.

No. 1 Flaxseed. No. 1 Flaxseed shall be northern grown, sound, dry, and free from mustiness, and carrying not more than twenty-five per cent. of immature or field, stack, storage, or other damaged flaxseed, and weighing not less than fifty pounds to the measured bushel of commercially pure seed.

Rejected Flaxseed. Flaxseed that is bin-burnt, immature, field damaged, or musty, and yet not to a degree to be unfit for storage, and having a test weight of not less than forty-seven pounds to the bushel of commercially pure seed, shall be rejected.

No Grade Flaxseed. Flaxseed that is damp, warm, mouldy, very musty, or otherwise unfit for storage, or having a weight of less than forty-seven pounds to the measured bushel of commercially pure seed, shall be No Grade.

Note. No grain shall in any case be graded above that of the poorest quality found in that lot, when it bears evidence of being plugged or doctored.

*Adopted August 31, 1904.

CHAPTER VIII.

GRASSES.

TIMOTHY.

History. Some claim that timothy is a native of America; others that it is a native of Europe. Probably it grew wild in both hemispheres. The name "timothy" was given to it in this country from the fact that Timothy Hanson, of Maryland, imported the seed from England. This importation took place about 1720. Timothy is sometimes called "Herd's grass," from the fact that a man named Herd found it growing wild in New Hampshire, and began its cultivation.

Manner of Growth. Timothy is a perennial, produces but one crop in a season, and furnishes very little aftermath. It starts to grow rather late in the spring, and is not ready to cut until July.

Climate and Soil. Timothy is not a strong drouth resister, so may not do well in sections where long drouths are frequent. It often produces a big crop on rich, well-drained soil, where the rainfall is abundant.

Sowing. Timothy may be sown with any of the small grains, either in the fall or spring. Fall seeding is generally to be preferred, but in sections where fall grain is not common, it will be necessary

to sow timothy in the spring, or else by itself. If sown without a nurse crop, from ten to twelve pounds of seed per acre may be used. When grown for hay, it is commonly mixed with red clover. As timothy ripens two or three weeks later than red clover, the clover must be cut when overripe or the timothy be cut green. As the seeds are small, they must not be sown deep. The seed weighs forty-five pounds to the bushel.

Harvesting. To get the greatest yield of hay, timothy should be cut just after flowering. If not cut then, the stalks become woody, and a large part of the digestible matter is stored in the seed. Timothy hay is easily cured, and there is a great market demand for it.

JUNE GRASS.

History. June grass is indigenous to both hemispheres, and is very popular, especially in this country. It is grown all the way from Southern Kentucky to Winnipeg, and is often called "blue grass," or "Kentucky blue grass."

Manner of Growth. June grass has underground root stocks, by means of which it spreads continually, and it is also propagated by means of seed. Ordinarily, June grass does not grow high enough for hay, but makes good pasture, especially during moist seasons. The growth is almost stopped during dry spells, because its comparatively short roots are not able to reach moisture in the lower soil. This grass is a great fighter, crowds out most other grasses, and occupies more space each year.

In meadows it is a weed, ripening too early for other grasses, and yielding very little hay; but it is the best lawn grass we have, making a very heavy sod, and producing a thick growth of leaves next to the ground. June grass is somewhat slow in starting, and usually requires about three years to form a complete sod.

Seeding. When sown for pasture, June grass is usually mixed with timothy, red top, or some of the clovers, which produce pasturage while the blue grass is getting established. The other grasses are killed out by June grass when it becomes well rooted. The yield of seed is very light, and the seed is rather difficult to harvest, thresh, and clean. Three bushels of seed are required to sow an acre. The seed weighs fourteen pounds per bushel, and usually costs from one dollar to one dollar fifty cents a bushel. Perhaps a mixture of blue grass and white clover is as good a combination for lawns as we have.

Uses. June grass is the best of lawn grasses, makes excellent pasture, but does not yield well for hay. In Kentucky it is used to a great extent for winter as well as for summer pasture.

RED TOP.

Red Top grows from one to two feet high, is perennial, and has creeping underground stems or root stocks. In appearance it resembles June grass, but grows taller. The head, which is loose and branching, has a purple tinge, and has smaller and more numerous spikelets. There are several varie-

ties that grow wild in low, wet places in this country. It starts rather late in the spring, blossoms about the same time as timothy, and produces very little aftermath. It yields from one to two tons of hay per acre. The hay is of good quality, but rather light for its bulk. Red Top forms a very compact sod, but is a little slower in occupying the entire soil than timothy. Two years are usually required for Red Top to form a well-established sod. It will drive timothy out after a few years if sown in a mixture. The sod is easily killed by plowing. This is a good grass to sow on very moist lands. It should be sown at the rate of from six to eight pounds per acre. The seed weighs fourteen pounds per bushel.

Fig. 22. Typical Growth of Brome Grass (Bromus Inermis.)

BROME GRASS.

History. Brome grass is a native to both Europe and Asia. In Europe it has been cultivated for more than a hundred years. It has been cultivated more extensively in Russia than in other European countries. It was brought to this country from Europe, and is now grown quite extensively in the northwestern states and in Canada.

Manner of Growth. Brome grass does well in a dry climate, is the earliest grass to start growth in the spring, and continues green latest in the fall. It forms a very dense sod. The roots often go downward to a depth of five feet or more. It is slow in making a start, and a fair stand is often plowed up as worthless at the end of the first season. After getting established, it will crowd out almost any other grass. In this respect it is probably superior to June grass.

Soil. Brome grass will grow on almost any kind of soil, unless it be soil that is very deficient in plant food.

Seeding. Sowing in the spring as early as the land is in good condition gives good results generally. A good stand is often secured by sowing the seed as late as the first of August on land that has been cultivated during the early part of the season to prevent the growth of weeds and loss of moisture. As a rule, it is best to sow it without a nurse crop. On land that is inclined to drift sow about five pecks of oats per acre with it. Cut the oats for hay when they are in blossom, in order that they may not dry out the soil too much. The seed may be sown broadcast, and harrowed in with a peg-tooth harrow. When sown in this way, use about fifteen to eighteen pounds of seed to the acre. It may be sown with a drill, but it will not feed evenly without help. It may be mixed with some heavy, inexpensive material, and in this way be made to feed through; or an appliance consisting of an inch

board, three inches wide, with spikes driven through to correspond with each cup in the seeder box, may be worked back and forth in the box. This causes the seed to feed quite evenly. Run the drill shallow,—about an inch and a half to two inches deep. If sown evenly with a drill, probably sixteen pounds of seed per acre will be enough.

First Season. The stand of grass during the first season usually looks very poor. Sometimes farmers have plowed up fields of it at the close of the first season, believing that it failed on account of poor seed or some other cause. It may, however, produce some late summer pasture during the first season. If weeds spring up during the first summer, they should be mowed to prevent too much shading, and to keep them from ripening seed.

Second Season. Brome grass will spread and occupy the ground in a surprising way the second spring, and usually produces a good crop of either hay or seed. Very few weeds have an opportunity to grow with it during the second season. If the grass is cut for hay, it should be mowed just after the blooming stage is passed, and the heads have become purple. It will then make good hay and produce an aftermath or second growth for pasture. The yield for the following years will also be better when the grass is not allowed to ripen seed. The number of years it may be kept in pasture has not yet been determined. A field on the North Dakota Experiment Station Farm, at the end

of the tenth season, continued to produce a profitable amount of pasturage.

When to Cut. If cut for seed, it should be harvested as soon as the color of the heads has changed from purple to brown. If cut when the hull covering the seed is purple, the seed will be light, and will not germinate well, and if left until the seed coverings are all brown, the loss from shelling will be considerable. When cut for seed, it is bound with the ordinary binder and shocked like grain until cured.

Threshing. In threshing Brome grass, shut the wind off close, or much of the seed will blow over with the straw. Some allow only the heads of the bundles to be knocked off by the cylinder of the separator, and then cast the bundle aside. That plan doubtless saves some seed, but it requires a greater outlay of labor. The seed is run through a fanning mill for final cleaning.

Breaking the Sod. If the sod is broken shallow as soon as the hay is taken off, and backset early in the fall, it will be practically dead at the time of backsetting, and will be in good condition for a crop of grain the following spring. If the grass is allowed to ripen seed before it is broken, it will be found more tenacious of life, and much of it will be found growing when backset.

MILLET.

History. Millet has been grown for many centuries in portions of Europe and Asia. It was one of the crops grown by the Lake Dwellers of Eu-

rope in prehistoric times. In some countries millet is grown chiefly for its seed, but in the United States it is grown principally for hay.

Manner of Growth. Millet is a short-season crop, and the early varieties may be sown very late. Common millet may be sown late in June in this latitude, and still produce a good crop of hay. Millet is a true grass, and, on account of its rank growth, is one of the best crops for smothering weeds.

Climate. Millet may be grown in almost all parts of the United States. It is quite a drouth resister, which probably accounts for its being grown so extensively in the middle west.

Soil. Millets are strong, rapid growers. They do best on a rich, porous soil, and are especially adapted to new breaking. The seed bed should not be compact, and should have a large percentage of humus.

Preparation of Seed Bed. The soil should be in fine tilth, clean and moist. Prepare the ground early enough to allow the weed seeds near the surface to germinate and be killed by cultivation before the millet is sown. This early preparation will, in addition to killing the weeds, warm the soil, conserve the moisture, and give finer tilth. This not only insures a larger crop, but makes millet one of the best uncultivated crops with which to clean the land of weeds.

Sowing. Millet is very sensitive to cold, and should not be seeded until the ground is warm, and

danger of long cold spells is past. It may be sown broadcast or with a drill, but under most conditions should not be sown deeper than two inches. Seed at the rate of about one-half bushel per acre. Heavy soils require more seed than light ones.

Classification. There are many recognized varieties of millet, all of which may be grouped into three general classes: (1) Fox-Tail Millets, (2) Broom-Corn Millets, (3) Japanese Millets.

(1) Fox-Tail Millets. There are many varieties of fox-tail millets, the most important of which are: Common Millet, Hungarian Grass, and German Millet. These three varieties are called "fox-tail millets" from the shape of their heads.

—Common Millet. Of the fox-tail millets, Common Millet is the earliest to mature, and is therefore very popular where the seasons are short. The seeds are yellow, and a little larger than those of Hungarian Grass. Several stems may be produced from a single seed.

—Hungarian Grass. Hungarian Grass has a smaller head than Common Millet, and is somewhat later in maturing. The seeds are mixed in color, some being yellow, and others dark purple. Hungarian Grass, like Common Millet, produces several stems from one seed.

—German Millet. German Millet usually produces one stem from a seed, is late maturing, and grows taller and coarser than the other varieties of fox-tail millets. It is a large yielder. The seed is yellow, and smaller than that of Common Millet.

German Millet is very popular in Texas, Oklahoma, and Kansas.

—**Siberian Millet.** Siberian Millet is a tall, heavy-growing kind, which is a little less coarse than the German Millet, and bears a somewhat more slender head. The seeds are longer shaped than those of the other fox-tail millets, and are reddish yellow in color. The Siberian is a heavy-yielding millet, and is becoming very popular in the northwest.

(2) Broom-Corn Millets. Most of the varieties of broom-corn millets are earlier than any of the fox-tail millets, and consequently may be sown very late. One variety of broom-corn millet, known as "Hog Millet," has recently become very popular in the Dakotas. The heads bear quite a resemblance to those of broom corn.

(3) Japanese Millets. One of the best known varieties of Japanese Millets is the one called "Barnyard Millet." A closely related plant is the common weed, which grows on moist, rich soils in nearly every part of the country, and which is called "Barnyard Grass." Barnyard Millet yields a large amount of hay, which is rather coarse in quality.

Feeding Value. Millet seed is grown in South Europe, parts of Asia, and in Africa, for human food. It resembles oats in the food elements which it contains. Ground millet seed, when cooked and mixed with raw cornmeal in the proportion of two pounds of dry millet seed to one pound of the cornmeal, forms a good fattening ration for hogs. Millet hay

is not a suitable feed as an exclusive hay ration for horses, but it gives good results as rough food for cattle and sheep.

Effect in Rotation. A change from small grain to millet gives the best results of any change recorded in a twelve-year trial at the North Dakota Station, except when a cultivated crop was introduced.

CHAPTER IX.

LEGUMINOUS PLANTS.

Manner of Growth. The leguminous class includes all plants whose seeds grow in legumes. By the aid of bacteria growing in nodules on their roots, they have the power to make use of the free nitrogen of the air contained in the soil spaces. This makes it possible for legumes to grow vigorously on soil that is poor in nitrogen compounds, if it is rich in other plant foods. In order to use atmospheric nitrogen, however, it is necessary that the soil shall contain the right kind of bacteria. If nitrogen fixing bacteria are not present in the soil, the legumes use up the nitrogen of the soil in the same manner as any other crop.

The Common Legumes. The following are the legumes commonly grown on the farm: Common Red Clover, Mammoth Clover, Alsike Clover, Crimson Clover, Alfalfa, Peas, and Beans.

Common Red Clover. Common red or medium clover is a perennial in some localities. In the northern states it is so likely to winter kill during the second winter that some consider it a biennial. It is usually sown in the spring with a nurse crop. It grows about two feet in height the second season, and the roots penetrate the soil to a considerable

depth. Red clover makes good pasture, and is well adapted for hay. It ripens about two weeks earlier than timothy, and when the two are grown together for hay, it will be necessary to cut them before the timothy has reached its maximum growth. If the clover is allowed to become overripe, the leaves, which form the best part of the plant, become brittle and drop off in handling. The yield of seed in the first crop is often light; but the second crop, which grows rapidly after the first is removed, often produces a large yield of seed. It is common to cut the first crop for hay and the second for seed. Common red clover, like other legumes, leaves the soil rich in nitrogen.

Mammoth Clover. Mammoth clover resembles medium clover very closely, but grows larger, is about two weeks later in ripening, and produces only one crop in a season. Like medium clover, it is sown with a nurse crop, and it often winter kills the second winter. Being of ranker growth, it is a little better than medium clover for pasture.

Alsike Clover. Alsike or Swedish clover is a perennial with small white heads which are tinged with red. It is smaller than medium red clover, being about half way between red clover and white clover. It does not produce as much hay as medium clover, but the hay is of excellent quality. There is a very light second crop. Alsike clover does well upon low, wet land which is flooded during a portion of the year.

Fig. 23. Corner in a North Dakota Alfalfa Field.

Crimson Clover. Crimson clover, sometimes called "scarlet clover," is adapted to a mild climate. It is an annual, and makes rapid growth even on light land. It can be distinguished by its long scarlet head. Crimson clover probably has no place in the states of the northwest.

Alfalfa. Alfalfa resembles clover in its growth. It is difficult to get started, but, when once established, is likely to be long continued. It is a perennial, has a smaller leaf than clover, and has purple blossoms. Alfalfa is deep rooted, hence is a great drouth resister. It must be cut early, or the stems become coarse and woody. In mild climates it is cut several times for hay during a single season. In the northwest it is very promising, but will probably not produce more than two crops a year.

Field Peas. Peas have been cultivated for so long a time that their native country is not known, but they are believed to be a native of southern or central Italy. They do best on light or sandy soils. The yield is better and they stand up better on light soils than on land which is very rich and heavy. Being legumes, they enrich the soil by taking nitrogen from the air and leaving it in the soil in an available form when their roots decay. It takes from two to two and a half bushels of seed to sow an acre. Peas may be sown broadcast or with a drill. The seed should be covered quite deep,—from three to three and one-half inches being none too deep. As peas lodge badly, oats are often sown with them

to help support them. It is a good plan to sow about two bushels of peas and one of oats. Peas sown in this way are very satisfactory as a forage, ensilage, or hay crop. If not lodged too badly, they can be cut with either the mower or reaper.

CHAPTER X.

POTATOES.

History. The potato is a native of America. It grows wild in Chili, Peru, Central America, and Mexico. Potatoes were not introduced into Europe until the sixteenth century, and writers of that time speak of them as food suitable for hogs and cattle.

Climate. Potatoes do best in a cool, moist climate. They yield better in the northern than in the southern states, but they may be grown in almost any region where any cultivated crop will grow.

Soil. Potatoes need a very rich soil. A light loam very rich in humus is to be preferred, though they do well on a well-drained clay loam. They need a loose soil, and will not do well on land that is compact.

Preparation of the Seed Bed. Potatoes require a thorough preparation of the soil. Deep plowing is the practice of the most successful potato growers. Spring plowing is preferred. After plowing, the soil should be smoothed with a harrow.

Cutting Seed. If the land is rich and well prepared, single eyed cuttings are satisfactory and probably preferable. Increase the size of your seed

piece if the soil is poor. The weight of the cutting is of more importance than the number of eyes. Hand cutting with careful selection of the pieces will pay best in the long run. Plant the cuttings as soon as they are made, and thus prevent drying out.

Depth of Roots. The roots go down about twenty-four inches. They grow close to the surface

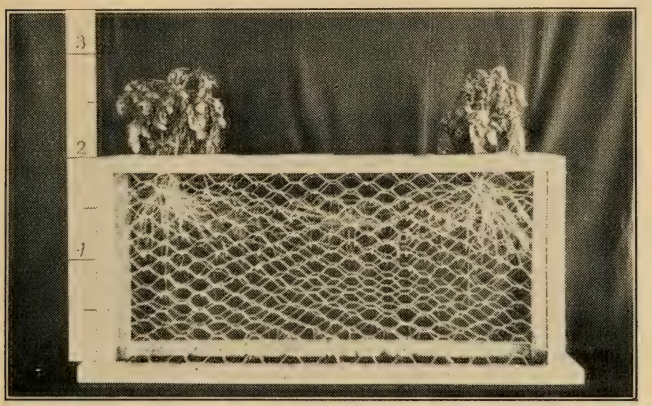


Fig. 24. Root Development of Half-grown Potato Plant (from a photograph).

also, and at the time of the last cultivation, or at the time the tubers are forming, two inches is as deep as one can cultivate without disturbing the roots. The potatoes do not grow on roots, but on underground stems.

Cultivation. Harrow within a week after planting, with a peg-tooth harrow. Repeat the harrowing often enough to keep down the weeds and to preserve a soil mulch. This should be continued

until the vines are three or four inches above the ground. Later, cultivate as for corn. It is not advisable to hill potatoes, except enough to prevent their becoming sunburned.

Bugs. As soon as the vines appear above ground, be on the lookout for potato bugs. When the bugs make their appearance, the vines should be treated with Paris green. Paris green may be applied with water, or it may be mixed with land plaster. If Paris green is of good quality, it is not likely to injure the vines. It is the soluble arsenic which it contains that injures the vines. If, after the Paris green has been mixed with water, a little quicklime is added, the soluble arsenic unites with the lime, becomes insoluble, and is thus prevented from damaging the vines.

Blight. Potato blight is a fungous disease, and, while it cannot be cured, it can be prevented. To prevent its getting a start, spray the vines with the Bordeaux mixture. Time will be saved if the Bordeaux mixture is mixed with the Paris green, and both applied at the same time. The Bordeaux mixture consists of six pounds of copper sulphate and four pounds of quicklime dissolved in forty gallons of water.

Scab. If the seed is at all affected with scab, it should be soaked for one hour in a formaldehyde solution, similar to that used in treating seed wheat.

Harvesting. Potatoes should be dug as soon as the leaves turn yellow, and before the stalks are dead. Care should be taken not to cut or bruise the

potatoes while digging, and they should be picked up and sorted very soon after they are dug. Potatoes are usually dug with a fork, but potato diggers with endless chain elevators do good work, and can be run deep enough to bring up all the potatoes whole and free from bruises.

Storage. Dark cellars are preferable for storing potatoes. Store in bins holding not more than three hundred bushels. Separate the bins with an air space, keep the temperature a little above freezing, and ventilate the cellar occasionally.

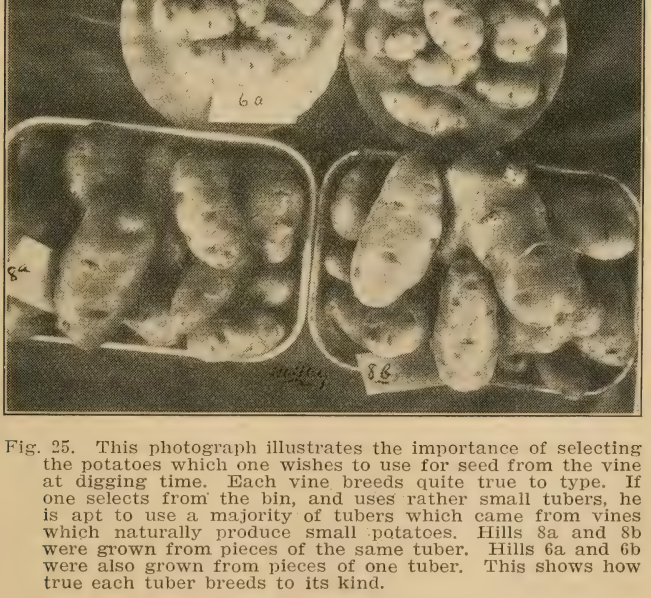


Fig. 25. This photograph illustrates the importance of selecting the potatoes which one wishes to use for seed from the vine at digging time. Each vine breeds quite true to type. If one selects from the bin, and uses rather small tubers, he is apt to use a majority of tubers which came from vines which naturally produce small potatoes. Hills 8a and 8b were grown from pieces of the same tuber. Hills 6a and 6b were also grown from pieces of one tuber. This shows how true each tuber breeds to its kind.

Selection of Seed. Select well-shaped, well-matured potatoes, from medium to large, that have not formed sprouts before planting. Good potatoes from the best hills make ideal seed.

Varieties. Plant varieties that sell well on the market, and which yield well. The point of yield is best settled by actual trial. There are a great number of varieties, and new ones are constantly coming out. Among the early varieties the following may be mentioned: Early Rose, Rose Gem, Six Weeks, Snowflake, Early Vermont, Sunrise, Beauty of Hebron, and Early Ohio. Late varieties: Rural New Yorker No. 2, White Star, White Elephant, Mammoth Pearl, Burbank, Peerless, Dakota Red, and Prolific.

FIG. 26. VARIETY TYPES OF POTATOES.

1. North Dakota No. 63, Salzer's Earliest.
2. North Dakota No. 73, White Ohio.
3. North Dakota No. 48, Six Weeks.
4. North Dakota No. 39, Early Andes.
5. North Dakota No. 58, Early Ohio.
6. North Dakota No. 60, Early Mayflower.
7. North Dakota No. 45, Early Beauty of Hebron.
8. North Dakota No. 67, Secretary Wilson.
9. North Dakota No. 79, Snow Flake.
10. North Dakota No. 74, Thoroughbred.
11. North Dakota No. 75, Abundance.
12. North Dakota No. 42, Early Rose.
13. North Dakota No. 50, World's Fair.
14. North Dakota No. 46, Burpee's Superior.
15. North Dakota No. 43, Cannon No. 1.
16. North Dakota No. 47, Rural New Yorker No. 2.
17. North Dakota No. 69, Hundred Fold.
18. North Dakota No. 59, Ideal.
19. North Dakota No. 54, Pingree.
20. North Dakota No. 55, Freeman.
21. North Dakota No. 65, Free Silver.

CHAPTER XI.

RAPE.

Rape has been grown in England for many years. There are both spring and winter varieties, but the winter kinds are not hardy enough for the northern states. Rape belongs to the mustard family, which includes the turnip and cabbage. It has the strong flavor characteristic of plants belonging to its family. This causes rape to be very palatable to cattle, sheep, and hogs; but it will not do to feed rape to milch cows, except immediately after milking, as it gives the milk a disagreeable flavor. Care must be taken, or it may cause sheep and cattle to bloat. Rape is especially valuable for sheep and hog pasture. If not grazed too close when young, rape will furnish a large amount of pasture to the acre. Rape may be sown as early in the spring as the land can be worked, or as late as the first of July if desired for fall pasture. It may be sown in rows far enough apart for cultivation, in six-inch drills, or broadcast. It requires three pounds of seed per acre when sown in drills thirty inches apart, and five pounds when sown broadcast. Rape may be sown with wheat or other small grain, to make pasture after the grain is harvested. The seed is like turnip seed in appearance.

CHAPTER XII.

ROTATION OF CROPS.

Importance of Rotation. If the farm is well adapted to a certain valuable crop, why not grow that crop on the same soil year after year? This is being done in many parts of the western states, especially in those sections where wheat can be profitably grown. This practice is not wholly to be condemned, as wheat can be produced with less expense for labor than many crops, and it also gives the new settlers quick returns in the form of ready money. On the other hand, the growing of any crop continuously on the same land must sooner or later bring about the impoverishment of the soil, unless the fertility of the land is kept up by heavy manuring, or by the application of commercial fertilizers. Even the rich soil of the Red River Valley is already beginning to feel the effects of the too-continuous production of grain crops. This is shown in the small wheat yields where wheat has followed wheat continuously, as compared with the crops of wheat after corn or other cultivated crop.

Reasons for Rotation—Labor. When several crops, each ripening at a different time, are grown, it is much easier for the farmer to harvest them all. If he produces a large variety of crops, and keeps

a fair amount of live stock, he is enabled to give employment to his men for a longer period, thus making it possible to secure better and more reliable help.

Rotation Affects the Soil Chemically. The various crops are all composed of the same elements, but not in exactly the same proportion. They all take practically the same kinds of food from the soil, but they do not take the same amount of each kind of food. This fact must not be made too much of, however, as plants differ only slightly in their food requirements. Certain crops, such as clover and alfalfa, often leave the soil richer in nitrogen than they found it. Such crops are very valuable in the rotation.

Rotation Affects the Physical Condition of the Soil. Soil is given different cultivation for the various crops. For some crops we plow deeper than for others; some are cultivated, others not; and some do better on fall plowing, while for others the land should be plowed in the spring. Some crops are deep rooted, others shallow; some have large tap roots, while others do not. All these variations affect favorably the physical condition of the soil, and bring about the production of larger crops.

Crop Rotation and Weeds. Growing the same crop year after year on the same land may be just the right treatment to encourage the growth and distribution of certain weeds. In order to keep the soil reasonably free from weeds, it is necessary to grow some cultivated crops. This will not free the

Fig. 27. Method of Exhibiting Grain and Forage Crops.

soil entirely from weeds, but will hold them in check, and greatly increase the crop yield.

Effect on Plant Diseases and Injurious Insects. If a crop is planted in the same place year after year, it is much more likely to be attacked by insects and diseases than if planted there only once in three or four years. For example, corn is more likely to be injured by smut, and potatoes by potato bugs, when grown on the same land several years in succession.

Rotations. There are several series of rotations that give excellent results in the northwest. One of the best consists of a crop of corn followed by two or three crops of wheat and flax. Potatoes, summer fallow, or millet may take the place of corn in the four-year rotation. As a rule, three crops of wheat following a crop of cultivated corn yield as much wheat as if the land had been in wheat all four years. In case the soil is lacking in nitrogen, clover, alfalfa, or some other legume should find a place in the rotation.

CHAPTER XIII.

WEEDS.

Definition. A weed is a plant out of place. Even our cultivated plants become weeds when they grow where they are not wanted.

Classification. Weeds may be divided into three classes,—annual or one-year weeds, biennial or two-year weeds, and perennial or many-year weeds.

Disadvantages of Weeds.

1. They rob cultivated plants of nutriment and moisture.

2. They injure crops by crowding and shading.

3. They retard the work of harvesting grain by increasing the draft and by extra wear of machinery (bindweed, thistles, kinghead).

4. They retard the drying of grain and hay.

5. They increase the labor of threshing, and make cleaning of seed difficult.

6. They damage the quality of flour, sometimes making it nearly worthless (cow cockle, corn cockle).

7. Most of them are of little value as food for domestic animals.

8. Some weeds injure stock by means of awns (squirrel tail, wild oats, porcupine grass).

9. Some of them injure wool, and disfigure the

manes and tails of horses (burdock, cockle burr, wild liquorice).

10. A few make hair balls in the stomach.

11. Some injure the quality of dairy products (leeks, wild onions).

12. Water hemlock, death camas, and lupines are very poisonous.

13. Frenchweed, and probably others, when eaten by animals, injure the taste of meat.

14. Many weeds interfere with a rotation of crops.

15. All weeds damage the appearance of a farm and render it less valuable (quack grass, Canada thistle, Russian thistle).

Some Small Benefits.

1. They are of some use in the world to induce more frequent and thorough cultivation, which benefits crops.

2. In occupying the soil after a crop has been removed, they prevent loss of fertility by shading the ground.

3. Weeds plowed under add some humus to the soil (adapted from Dr. W. J. Beal).

Weeds of Special Interest. Among the worst weeds found in North Dakota are wild oats, wild buckwheat, Russian thistle, pigeon grass, quack grass, wild barley, cow cockle, tumbling mustard, yellow mustard, French weed, kinghead, and Canada thistle. Not all of these are found in every part of the state, but where found they do much damage:

Fig. 28. A representation of a collection of weed seeds characteristic of North Dakota. This collection is prepared and labeled for educational purposes by the Botanical Department of the North Dakota Agricultural College, and may be had for school work upon application to the secretary of the College.

(1) Wild Oats. This is a bad weed of the first rank. It is an annual, and most abundant in the eastern part of the state, especially in the Red River Valley. The plant and the grain resemble that of the cultivated oats. The grain has a horseshoe shaped ring of hairs at its base, is yellowish or blackish in color, and bears on the back a blackish, twisted, and bent awn about one inch long. The grain is of light weight. The wild oat plant is quite different from the porcupine grass found on the prairies, which has a twisted awn several inches long. The latter is often wrongly called wild oats. Wild oats ripen early, shell easily, and probably remain in the ground many years without germinating, at least when the ground is dry. Wild oats may grow when three or four inches underground. They can never be gotten rid of if the land is cropped to grain continuously. Farmers have succeeded in removing wild oats from their land in a variety of ways. The following is one of the most thorough methods: Plow the ground shallow in the fall after the crop has been removed. In the spring, plow the land deep, and summer fallow that season, keeping the ground clean mainly by the aid of the spring-

Fig. 29. Wild Oats.

tooth harrow. Without plowing, grow a crop of flax or barley the next season. Pull the few wild oats that may be found in the barley or flax. Plow deep early in the fall. Summer fallow the piece clean the next year in the same manner as before, and put the summer fallow into wheat or barley the year following without plowing, harrowing the ground well before seeding. This method calls for an extra summer fallowing, but the fact that the land is freed from wild oats should repay the extra work.

(2) Wild Buckwheat. This well-known annual is found everywhere in the state where cultivation has been carried on. It has a twining or trailing stem, the leaves approach the triangular in outline, and the flowers are inconspicuous. The seeds are about one-eighth of an inch long, three-angled, and dull black. The seed is difficult to remove from wheat. This plant produces a large amount of foliage in a short time, and so suffocates the growing crop. There is no infallible rule for the treatment of this weed. It does the least damage to those farmers that pay careful attention to pure seed, intensive farming, and good rotation.

Fig. 30.
Wild Buckwheat.

(3) Russian Thistle. This famous weed is well known over the light soils of the state, but in the Red River Valley region it is scarce. When young

it is dark green, with soft, narrow, awl-shaped leaves. As the leaves become older they develop prickles on their ends, which fact, coupled with the home of the plant, gives it its name. It is related neither to the thistles nor to the cacti, but is a near relative of the pigweed. The best means of repression are cultivated crops and clean summer fallow, cutting oats or millet containing it for hay, firing wheat stubble, and cutting plants in waste places. Plants in waste places are apt to form the big rollers, which do so much in the way of distributing seed. This plant need not be feared in thickly settled communities if the land is handled correctly.

Fig. 31. Russian Thistle.

(4) Pigeon Grass; Yellow Foxtail; Wild Millet. This introduced weed is found almost everywhere in cultivated ground. It is particularly abundant in grain fields, potato patches, and gardens. It is an annual, and germinates about the first of May. When young it can be told from all other grasses, except cockspur, by its rather wide leaf and the reddish color of the stems near the ground. The heads of this grass resemble those of common and other similar millets, but are somewhat smaller. The seeds are yellowish, oval, and rather hard. They are easily removed from wheat, but are difficult to remove from flaxseed. This weed is present

under the most careful methods of farming. All that can be done is to reduce its ravages to a minimum. Pure seed grain is an efficient factor here, as elsewhere. Early seeded grain gets started ahead of pigeon grass.

(5) Quack Grass; Couch Grass. Quack grass is a valuable forage and hay grass, but because of its persistent underground stems it is difficult to eradicate when the land is desired for cultivation. These stems are easily reached by the plow. This grass must be handled in a dry season. The land is plowed shallow and cultivated continuously. The following season the ground is seeded heavily to brome grass. When the brome grass is cut for hay, the sod is broken and backset in the fall. This is followed by a cultivated crop or by wheat. Small areas may be killed by smothering with a thick application of straw or manure.

Fig. 32. Quack Grass.

(6) Wild Barley; Foxtail; Flickertail. This grass, which is related to the field barley, is easily recognized by its habit of invading lawns and pastures, and by its long, spreading awns. The awns are very injurious in hay. The leaves and stems are bluish-green, and covered by soft hairs. The nodding heads resemble those of common barley, but are softer and the awns finer. This plant is eaten some

by stock while it is young, but is not often touched when the heads appear; thus, the grass is a positive damage to pasture. The awns injure the lining of the alimentary tract of an animal when taken in as part of the hay. They also lodge between the teeth of animals, and gradually work their way farther in, setting up inflammation and ulceration, causing the teeth to drop out in some cases. Inflammation may continue until the greater part of the jawbone becomes diseased. This grass is difficult to eradicate. When practicable, it should be cut before the heads ripen, and then burned. If necessary, it should be recut. If much of it is found in a field, the ground should be broken in June, cropped, and seeded to brome grass. It is easily killed by plowing, but the land soon becomes reseeded by the wind. It bothers seriously in overstocked pastures.

(7) Pink Cockle; Cow Cockle; Cowherb. This annual is found in grain fields over the larger portion of North Dakota. It is from one to three feet high, with a spreading top, bearing a large number of pink flowers about one inch in length. The leaves are very smooth, and opposite to each other on the stem. The seeds are nearly black, spherical, roughened, and about twice the size of mustard seed. Because of the difficulty of their removal from wheat, their presence "cuts" the grade. The seeds are poisonous, and flour made from wheat containing them is injurious to health. When in blossom, the plant is easily recognized in grain fields, and when not abundant should be pulled.

It would probably pay to pull it, even when it is abundant. If clean seed grain is sown, the weed can easily be eradicated, provided a good system of rotation is followed.

(8) Tumbling Mustard. This weed, sometimes called white mustard, is most abundant in the lighter soils of the state. In the flax fields of the central portion of North Dakota it seems to take almost complete possession. The flowers are nearly white or faint yellow in color. The leaves are oblong in shape, and cut-toothed. The pods are long and very slender, and may contain over one hundred seeds. The seeds vary in color from reddish yellow to yellowish green, and are the size of a naked timothy seed. The plants become very bushy if allowed room to develop. They die in September, after the hard frosts, and, breaking loose from the ground, they are rolled hither and thither by the wind. The seeds are not easily released from the pod, and so much rolling and pounding is required to distribute them. One plant may develop 1,500,000 seeds, which would seed five acres, allowing seven seeds to the square foot. The large "tumblers" that form in waste places should be destroyed. The

Fig. 33. This figure illustrates a seedling plant of the destructive weed known as Tumbling Mustard. Many annual plants such as tumbling mustard and pennycress produce seedlings in the fall of the year, which are not killed by the freezing of winter. These grow rapidly and do great damage the following spring, if not destroyed.

stubble should be burned in the fall, and the land plowed in the spring. Flax should not be seeded. This weed does not cause loss if the land is clean at the time the grain is seeded, so that the grain will have equal chances with the tumbling mustard.

(9) Yellow or Wild Mustard. If this well-known plant is not too thick in the field, it may be pulled each year until the field is free from it. If the mustard is too abundant to allow a crop to grow, it should be cut when in full bloom, and either plowed under or burned. Summer fallow the land clean that season. Grow a crop of millet or oats the next season, cutting it green. Try a crop of corn the next year, keeping it clean. Sow the corn stubble to wheat without plowing. Pull all of the mustard each year to prevent the development of any seed. Whenever a large number of mustard seeds are brought to the surface by plowing, the crop grown on such land is preferably a cultivated crop. If the mustard infested area is too large to be handled at one time, seed a portion of it to brome grass. When the brome grass sod is broken, the mustard seed should be germinated and killed as outlined above.

Fig. 35. Wild Mustard.

(10) French Weed; Pennycress; Stink Weed. Vicious and abundant as this plant is in parts of North Dakota, many farmers do not know it when it is young. It germinates either in the fall or

spring. In the former case it lives through the winter and ripens the next season. The pods are flat, circular, winged, one-half inch in diameter, and contain about sixteen brown seeds, one-twelfth of an inch long. As the plant approaches maturity the leaves drop off and their work is done by the large, green pods. The plant varies from two inches to nearly three feet in height, and bears from one to five thousand pods. It seeds in dense timothy sod almost as well as in untouched summer fallow. It thrives in waste places, and is at home in flax and wheat fields. In general, it should be treated as yellow mustard.

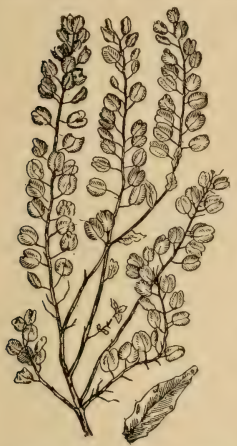


Fig. 36. This cut represents the top of a nearly mature French weed sometimes called "pennycress," sometimes "wild garlic," sometimes improperly called "shepherd's purse." This illustrates why botanists persist in using Latin names for all plants and animals. This plant reproduces only by seed, and the winged pods provide a splendid means for scattering the seeds. See North Dakota Experiment Station Bulletin No. 56.

(11) Great Ragweed; Kinghead. This plant is an annual, and attains a height of six or even eight feet. Its leaves are large and deeply cut. It is best known on account of its "seeds" or akenes. These are light in weight, yellowish or brownish, one-fourth inch long, and have an encircling row of projections,

Fig. 37. Ragweed.

whence the name "Kinghead." These seeds are so difficult to remove from wheat that their presence in any quantity causes the grade to be reduced. It infests crops more particularly in low lands. The plants should be pulled the latter part of June or early in July, before the seeds have formed.

(12) Canada Thistle. The aggressiveness, the rank growth, the ease of seed distribution, the increase of the plant by underground stems, and the spiny leaves make the Canada thistle dreaded above nearly all other plants, where known. It is a true thistle, and is distinguished from the prairie thistle by the leaves being a darker green, without prickles or hair on their upper surface, and by their heads having no prickly spines. It grows in very dense patches. It is held by some that this plant does not bear seed capable of growing. This is certainly not true of North Dakota plants. Although this plant grows from underground stems, its life depends ultimately upon the green leaves it produces above the

Fig. 38. Canada Thistle. Showing its method of growth from under-ground root stocks. New plants sprout up from every joint in this stock. See Experiment Station Bulletin No. 56.

ground. The green leaves constitute a sort of stomach for the plant, and as long as these are present the plant will grow and add new material to itself. A portion of this new material will be stored in the underground stems as reserve food material. If the stems of the thistle above ground, the aerial stems, are cut off, the thistle plant draws upon its reserve food material for the production of new leaves. If the aerial stems continue to be cut off, there comes a time when the reserve food material becomes exhausted, and no more leaves can be produced. The method of killing the thistle consists in preventing the plant from producing green leaves until its reserve food is used. This may be done by continuous cutting, by smothering, or by cultivation.

CHAPTER XIV.

INJURIOUS INSECTS.

Extent of Injury. Agricultural success or failure often depends upon the absence or presence of certain destructive insects. Practically all cultivated plants are more or less subject to insect attack. The total damage each year in the United States from injurious insects is estimated at $300,000,000.

Controlling Injurious Insects. Except for the constant effort to keep these destructive foes of field and orchard within reasonable bounds, the loss would be much greater, while certain crops could not be grown at all. In recent years much improvement has been made in the matter of fighting insects. Fruit growers especially, by means of improved machinery and remedies, have greatly lessened the cost and labor of keeping destructive insects under reasonable control.

Knowledge Necessary. The careful study of injurious insects, to obtain a knowledge of their life history, is of the greatest importance. Without it one could hardly hope to meet with success in fighting them. One engaged in farming is naturally interested chiefly in the insects of his own region. These are usually not so numerous that he cannot learn their habits.

Habits of Insects. The habits of insects determine the methods to be used in their extermination. For instance, some insects get their living by sucking the juices of plants, and so cannot be poisoned. Plant lice belong to this group. Others, like the cutworm, feed on the part of the plant below the soil, and so demand some special treatment. The same is true of insects that live inside of the plant, of which the Hessian fly is an example. The treatment that would destroy the potato beetle would not affect these. There are still other insects, like the grain louse, for which there is no treatment but what would cost more than the value of the crop.

Remedies. The remedies for injurious insects may be grouped roughly under two heads: First, mechanical treatment, such as plowing, burning, etc.; second, destroying with poisons and other materials fatal to insects. The second group of remedies may be divided into two parts: (1) The true poisons, which are applied to the plants on which the insect feeds; (2) such substances as kill by coming in contact with the insect, like kerosene and tobacco. A study of the manner in which insects breathe will explain why an external application of the last-named materials is fatal to insects and not to animals.

Our Worst Insects. The insects most destructive in North Dakota, or regions having a similar climate and producing the same crops, are the Hessian fly, grasshopper, potato beetle, army worm, and canker worm. The damage from the Hessian fly

alone in North Dakota sometimes reaches $2,000,000 in a single season. Fortunately, most of these pests are controlled with comparative ease under our conditions. In regions where wheat is sown in the fall it often becomes necessary to give up the growing of this crop for one or two seasons on account of the Hessian fly. The other insects named, with the exception of the potato beetle, are found in destructive numbers only occasionally, and then usually over but a small area. For this reason, the total amount of their destruction is not very great.

(1) The Hessian Fly. The Hessian fly, like most other insects, passes through three stages in its development. The adult insects are very small, —about half as large as a mosquito and of much the same shape. They appear in May, laying their eggs in the young wheat plants close to the ground. The egg soon hatches into a tiny white grub, which works its way between the leaf and young stalk, where it sucks the juice of the plant. In the course of three or four weeks this grub stops feeding and takes on a tough, brown coat. In this stage, called "pupa," it somewhat resembles a flaxseed, though smaller and narrower. If very numerous, the plants turn brown, having a weak, sickly appearance. After a few days the case breaks open, and the second brood of adults appears, many times more numerous than the first. This brood also lays its eggs on the wheat plants, but this time at the second joint above the ground. This is done late in June and in July. The white grub hatches and feeds as

before, and, about the time the grain is ripening, develops into the flaxseed stage. In this stage it remains in the stubble over winter, giving rise in the spring to the first brood of adult insects already described. The damage done by the second brood is easily seen and estimated. At the time of ripening, the infected stalks break over just above the point where the insect has been feeding during the season,—that is, at a point about half an inch above the second joint from the ground. These heads contain but little grain, and, falling to the ground as they do, cannot be harvested. The remedy is to plow or burn the stubble in the fall or very early in the spring. A few acres of stubble left in a field where the fly worked the year before would be sufficient to infest a whole section.

(2) Other Injurious Insects. The life history of some of our other insects is quite as interesting as that of the Hessian fly, but cannot be given here. There are many books and pamphlets published by the government and by the different experiment stations that tell the story of these in an interesting manner.

CHAPTER XV.

CATTLE.

Origin and History. Cattle were domesticated in prehistoric times, but there is little information concerning them until the beginning of the seventeenth century. From the testimony of rocks it is known that cattle existed in the northern part of Europe previous to the glacial period. Except the buffalo, no cattle existed in America before its discovery by Europeans. The improved breeds of cattle have been derived from Great Britain, with the exception of a few that originated on the continent of Europe.

Classification. Cattle may be classified with reference to their horns as long horned, medium horned, short horned, and polled. The long horned breeds are represented by the West Highland, and by the breed known as Longhorns. The medium horned breeds are the Hereford, Sussex, Devon, and Ayrshire. The short horned breeds are the Shorthorn, Jersey, Guernsey, and Kerry. The polled or hornless breeds are the Aberdeen Angus, Galloway, Polled Durham, and Red Poll. Cattle are also classified on the basis of utility as beef, dairy, and dual purpose.

Beef Form. The beef form is compact, wide,

and deep. The back is broad, well fleshed, and straight. The front quarters are wide, deep, and full, and the hind quarters long, wide, and deep. The beef animal should have soft, elastic flesh and a pliant skin.

Dairy Form. The dairy animal has a long, deep body, which shows a large capacity for the consumption of food. The head, neck, withers, thighs, and limbs are refined in form, and the udder and milk veins are well developed. The dairy animal has a large chest and much width through the heart, indicating good constitution. The eyes are clear, and the skin pliable and elastic.

Dual Purpose Form. The dual purpose breeds combine the qualities of the beef and dairy breeds to quite an extent. They are not so compact or blocky in form as the beef breeds, and the udder and milk veins must be well developed. The dual purpose animal should have a large heart girth to indicate good constitution; the head and neck should be long and fine, and the ribs fairly well sprung, open spaced, and covered with a soft, pliable skin.

THE BEEF BREEDS.

The following are the beef breeds in the order of their size, beginning with the largest: Shorthorn, Hereford, Aberdeen Angus, Galloway, Sussex, and West Highland.

Shorthorn. (1) Origin and History. The Shorthorn breed of cattle is named from the shortness of its horns. It is also called Durham, from Durham

county, England, where the breed originated. The terms "Shorthorn" and "Durham" are now regarded as synonymous. Shorthorns are descended

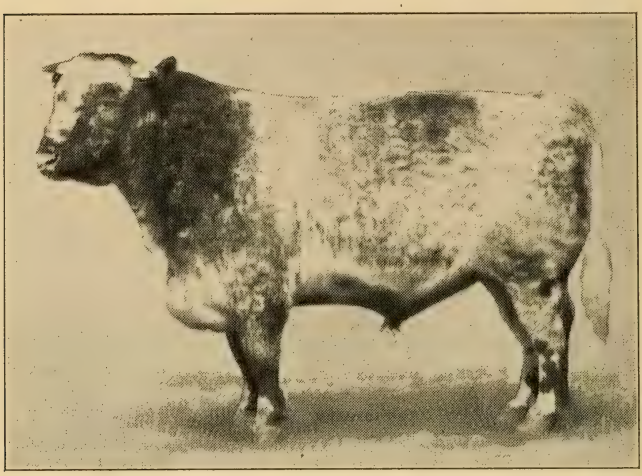


Fig. 39. Short-Horn Bull "Ceremonious Archer" 171479; Champion at the International Show in 1903. Owned by Frank O. Loudon, Oregon, Ill.

from two breeds, the Teeswater and Holderness. The early improvers of this breed were the Colling Brothers, Bates, Booth, and Cruickshank.

(2) Strains. The three strains of Shorthorn cattle, known as the Bates, Booth, and Cruickshank, got their names from the famous breeders mentioned above. The Bates Shorthorns were famous for their size and large milk production, the Booth had great heart girth, a long hind quarter, and deep, mellow flesh, but lacked style, while the Cruickshank Shorthorns were smaller but more compact than either the Bates or Booth strains.

(3) General Appearance. The standard colors of the Shorthorn are red, white, and roan. Red is quite popular, white is not very common, and roan is gaining in favor.

(4) Popularity. At present the Shorthorn is the most popular breed of cattle in the world. They are favored on account of their great utility. Shorthorns are classed among the dual purpose breeds as well as among the beef breeds.

(5) Adaptability. Shorthorns are best suited to arable countries, but adapt themselves readily to changes of soil and climate. Their great size makes them ill adapted to mountainous countries. They graze only fairly well, and should be provided with good pastures. Shorthorns feed well, fatten rapidly, and rarely become patchy.

(6) Beef Qualities. They mature early, and with suitable feed and care may be made ready for the block at the age of two and one-half years. The meat is tender, juicy, and nutritious, and is surpassed in quality by that of few other breeds.

(7) Milking Qualities. The milk is fair in quantity, and of excellent quality. The milking strain of the Shorthorn ranks well from the standpoint of milk production.

(8) Weak Points. Sometimes they lack in constitution. This has been brought about by in and in breeding and highly artificial treatment.

Herefords. (1) Origin and History. The Hereford breed of cattle is descended from one or more of the aboriginal breeds of Great Britain.

Their original color was probably red, and their white markings are alleged to have come from their

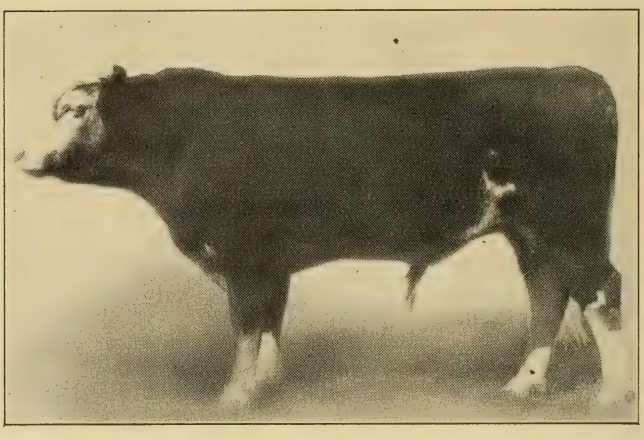


Fig. 40. Yearling Hereford Bull "Santa Claus Hesiod" 200880. Bred by Massingham and Cosgrove, Harmon, N. D. Owned by the North Dakota Agricultural College.

having been crossed with the white cattle of Wales, and the white-faced Flemish breed.

(2) General Appearance. The face, throat, chest, legs, lower part of the body, and tip of tail are white, all other parts being red. They are rectangular in form, and compact.

(3) Popularity. During the early part of the nineteenth century, Herefords were as popular generally as Shorthorns. Shorthorns are more in favor at the present time with the average farmer, but Herefords are more popular on the ranges.

(4) Adaptability. Herefords adapt themselves readily to conditions of soil and climate. They are

well adapted to graze on rich, level land, and are equally suited to range conditions such as prevail in the western portion of the Dakotas. They are probably better adapted to warm climates than the Shorthorns.

(5) Grazing and Feeding Qualities. Their grazing properties are superior to those of the Shorthorns. Their feeding qualities are about equal to the feeding qualities of the Shorthorns, except that the Herefords are more inclined to patchiness.

(6) Beef Qualities. They mature as early as the Shorthorns. They dress well, and the quality of the meat is good.

(7) Milking Qualities. The milk ranks high in quality, but is often lacking in quantity. For this reason they must be considered strictly a beef breed.

(8) Weak Points. Their weakest points are their lack of milk production and lightness of thigh.

Aberdeen Angus. (1) Origin and History. The Aberdeen Angus is probably descended from the aboriginal cattle of Great Britain. It is believed that their ancestors had horns. No one knows how this breed lost its horns, but it probably occurred since domestication. This breed of cattle originated in Scotland.

(2) General Appearance. They are black in color, though a shade of brown is not rejected. White above the underline or on the legs excludes from registration. In form they are low set, and have long, round bodies.

(3) Popularity. The Aberdeen Angus cattle

were little known except in Scotland previous to the middle of the past century. They are now widely distributed throughout the United States, and are very popular as beef producers.

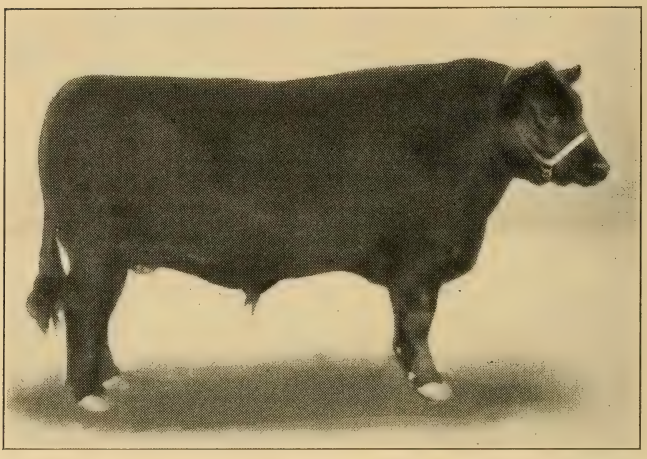


Fig. 41. Pure Bred Aberdeen Angus Steer "Clear Lake Jute;" Grand Champion at the International, 1904. Exhibited by the University of Minnesota.

(4) Adaptability. They do well on the western ranges, but are better adapted to a temperate climate, and to regions where shelter can be given them in winter.

(5) Grazing and Feeding Qualities. This breed does not graze well on rough land, or where pastures are poor, but they feed well, and rarely become patchy.

(6) Beef Qualities. They mature early, and the quality of the meat is rated a little ahead of that of the Shorthorns and Herefords, and nearly equal to

that of the Galloway and West Highland breeds. In percentage of meat to live weight they are unexcelled.

(7) Milking Qualities. Some individuals milk well. As a rule the quantity of milk is small, though the quality is good.

Galloway. (1) Origin and History. The Galloways are among the oldest of the improved breeds. They are descended from the aboriginal cattle of Scotland, and have been bred pure as far back as their history can be traced.

(2) General Appearance. Their color is black, and the hair is long and beautifully waved. On account of the long, wavy hair, their hides are much in demand for robes. In form they are low set, and compact.

(3) Popularity. They are not as popular as the Shorthorn, Hereford, and Aberdeen Angus breeds, but are gaining in popularity in the United States and Canada.

(4) Adaptability. The Galloway is one of the hardiest of the British breeds. They are well adapted to range conditions, and do better on scant pastures than most of the other beef breeds. Their long, thick hair protects them in wet and cold weather.

(5) Grazing and Feeding Qualities. Their grazing qualities are first class. They are able to rough it on poor pastures, and on rich pastures they put on flesh rapidly. They feed well, take on flesh

smoothly, and are almost entirely free from patchiness.

(6) Beef Qualities. The Galloways are a little late in maturing, but their meat commands the highest market price.

(7) Milking Qualities. Individuals milk well, but this is not generally true of the breed. Their milk ranks high in quality.

(8) Weak Points. Their weak points consist of undeveloped milking qualities and lack of size.

DAIRY BREEDS.

The following are the common dairy breeds in the order of their size, beginning with the largest: Holstein, Dutch Belted, Ayrshire, Guernsey, Jersey, French Canadian, and Kerry.

Holstein. (1) Origin and History. The Holstein is a very old breed. Its native home is Holland, where it seems to have been bred pure for about two thousand years. Holland was well known as a dairy region during the ninth century.

(2) General Appearance. The color is black and white, the head, neck, and limbs slender, and the form parallelogrammic, rather than wedge shaped. They are almost as large as the Shorthorns.

(3) Popularity. In America they are one of the most popular of the dairy breeds. The Jersey is probably the only dairy breed that is more popular.

(4) Adaptability. They are especially adapted to sections where the land is rich and level.

(5) Grazing and Feeding Qualities. Their large size prevents their grazing well on lands that are hilly, or where they have to travel far in search of food. They make good use of soiling crops and ensilage, especially when these are used as supplementary to their summer pasture. Holsteins feed well for beef up to the age of eighteen months, the meat being of excellent quality. As they approach maturity, the dairy type becomes more prominent, and they do not fatten so readily.

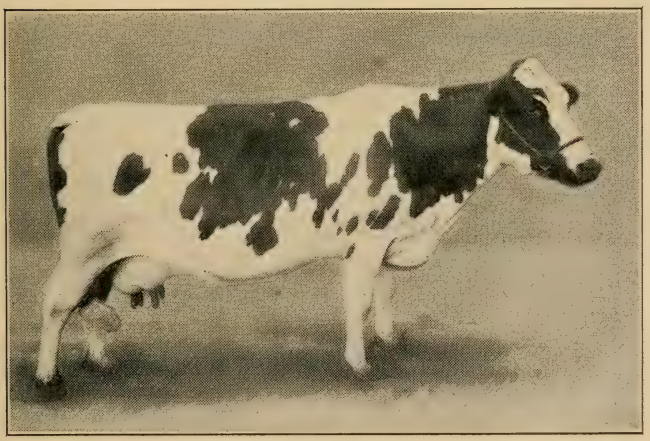


Fig. 42. Holstein Cow "Donation." Owned by the University of Wisconsin.

(6) Milking Qualities. In quantity of milk the Holstein stands first among all the breeds of cattle. The milk, on an average, does not test high in but-

ter fat, though the total amount of butter fat is large. The milk is rich in solids, not fat; and the percentage of fat is large enough to make the milk excellent for the production of cheese.

(7) Weak Points. Their milk gives a low fat test, and the quality of meat from the mature animal is not of a high grade.

Guernsey. (1) Origin and History. Guernsey cattle are named from their place of origin,—the island of Guernsey. This is one of the Channel Island group, which is in the English Channel between France and England. The Guernseys are probably descended from the cattle of Brittany and Normandy. They have been bred pure for many centuries on the island of Guernsey.

(2) General Appearance. In color they are red, light lemon, orange, and yellow fawn, usually with white markings. The white markings are commonly on the face, flanks, and legs. They are never gray,—a common color among the Jerseys.

(3) Popularity. The Guernseys are not as popular as the Jerseys. This is doubtless partly due to the fact that comparatively little effort has been made to bring them before the public.

(4) Adaptability. Guernseys are especially adapted to temperate climates, though they have done well in the vicinity of Quebec. They do better on arable lands than where the land is rough or the feed scarce.

(5) Grazing and Feeding Qualities. Their grazing qualities are only medium. They rank

ahead of the Jersey as meat producers, though the meat of the mature animal is not first class.

(6) Milking Qualities. Their milk tests nearly as high in fat as that of the Jersey, is slightly richer in color, and the average yield is probably greater.

(7) Weak Points. As dairy animals, their weak points are not pronounced. Perhaps their weakest point is their inability to rough it.

Jersey. (1) Origin and History. Jerseys get their name from the island of Jersey, one of the Channel Island group off the coast of France, and belonging to Great Britain. The Jerseys are probably descended from the cattle of Normandy, hence are related to the Guernseys. It is said that they have been bred pure on the island of Jersey for nearly five hundred years.

(2) General Appearance. They have a beautiful, deer-like form and a small head. When in milk they are inclined to be very thin.

(3) Popularity. Judging from their numbers, they are without doubt the most popular breed of dairy cattle in America.

(4) Adaptability. They are best adapted to temperate regions, but do well in comparatively cold climates. They do not thrive on sparse or rugged pastures.

(5) Grazing and Feeding Qualities. Jerseys should be kept on rich pastures. At maturity they have too much of the dairy form to fatten well, but up to the age of eight months they make fairly good meat.

(6) Milking Qualities. Jerseys are famous on account of the quality of their milk. In the production of milk rich in fat they have no close rival except the Guernsey and French Canadian.

(7) Weak Points. Their weak points are lack of size and delicacy of constitution.

DUAL PURPOSE BREEDS.

The following are the dual purpose breeds in the order of their size, beginning with the largest: Shorthorn, Polled Durham, Brown Swiss, Red Poll, and Devon.

Shorthorn. The Shorthorn is classed both as a beef breed and dual purpose breed. Some families of Shorthorns belong clearly to the beef breeds, while other strains have more of the dairy type, and may be classed as dual purpose. As the Shorthorn has been quite fully described under beef breeds, a more extended discussion is not necessary here.

Polled Durham. (1) Origin and History. The Polled Durham was developed in the United States from two different sources of ancestry. One branch is a cross between pure-bred Shorthorns and grade Mulleys, and the other is composed of pure-bred Shorthorns which are hornless.

(2) General Appearance. In appearance they are much like the Shorthorns, but they do not carry the beef form to so great a degree, are more developed in their milking qualities, and hornless. In color markings they do not differ from the Shorthorns.

(3) Popularity. They promise to become very popular as dual-purpose animals. At the World's Fair in Chicago, in 1893, the Polled Durhams won the sweepstakes prize, which was open to all dual purpose cattle.

Brown Swiss. (1) Origin and History. Brown Swiss cattle originated in Switzerland. They have been imported very extensively into Italy, Germany, and Russia. During the last few years, large numbers have been imported into the United States.

(2) Popularity. They are very popular in Europe, and are gaining in favor in the United States and Canada. Their popularity is undoubtedly based on merit.

(3) Adaptability. Being strong and vigorous, they can be kept profitably where most of the dairy breeds would prove a failure. They are best adapted, however, to arable soil, where both beef and milk are sought.

(4) Grazing and Feeding Qualities. Their grazing qualities are good, as their original home is a mountainous country where the land is rough and the feed often scarce. The steers make good beef, and the cows fatten readily when dry.

(5) Milking Qualities. They give a fairly large quantity of milk, and the quality also ranks high. They are easy to manage, and are becoming more popular for the dairy.

(6) Weak Points. Their weak points are lack of uniformity in type. They are rather coarse boned, which gives them a rough appearance.

Red Polled. (1) Origin and History. The Red Polled breed originated in England. They have

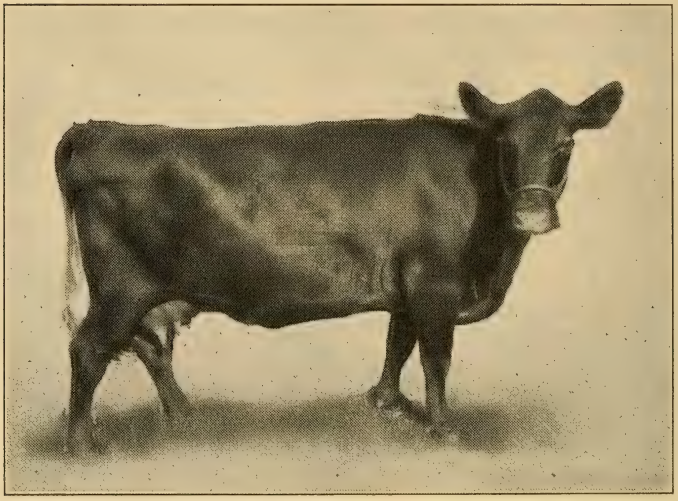


Fig. 43. Red Polled Cow "Celia." Owned by the University of Wisconsin.

been crossed with the Galloway, West Highland, and Shorthorn. They have been much improved by careful selection during the last fifty years.

(2) General Appearance. Their color is a deep red, but the tip of the tail may be white. They are somewhat smaller than the Shorthorn, and have less of the beef form.

(3) Popularity. Red Polls are probably the most popular of the general purpose breeds in the United States, and they are rapidly gaining in favor.

(4) Adaptability. Though they will thrive in

a severe climate, they are best adapted to milder conditions. They do best where the land is rich, and where they can receive the best of care.

(5) Grazing and Feeding Qualities. Their grazing qualities are about medium. They fatten rapidly when dry. The steers are medium in size, fatten readily, and make excellent beef.

(6) Milking Qualities. Red Polls give a large quantity of rich milk, and are very uniform and persistent in their milking qualities.

(7) Weak Points. They are a little deficient in heart girth, and lack uniformity.

CHAPTER XVI.

HORSES.

Horses are classified as light horses and draft horses. Light horses may be divided into three main classes: Carriage horses, road horses and saddle horses. The following are the common breeds of light horses: The French Coach, German Coach, Hackney, Cleveland Bay, American Trotter, Thoroughbred, and American Saddle Horse.

LIGHT HORSES.

Carriage Horses. Carriage horses are distinguished by their size, style, and action. They should be at least 16 hands high, smooth, and symmetrical. They are not expected to go fast, but are required to have high knee and hock action. They are used by the wealthy class of our cities to drive for pleasure. Most carriage horses are descended from the French and German Coach breeds, the Hackney, Cleveland Bay, and American Trotter.

Road Horses. Road horses, commonly called "Roadsters," should be about 15½ hands high, and weigh approximately 1,000 pounds. Essential qualifications for the road horse are speed and stamina. He invariably lacks the symmetry of the carriage horse. He is narrow and slender, and shows much

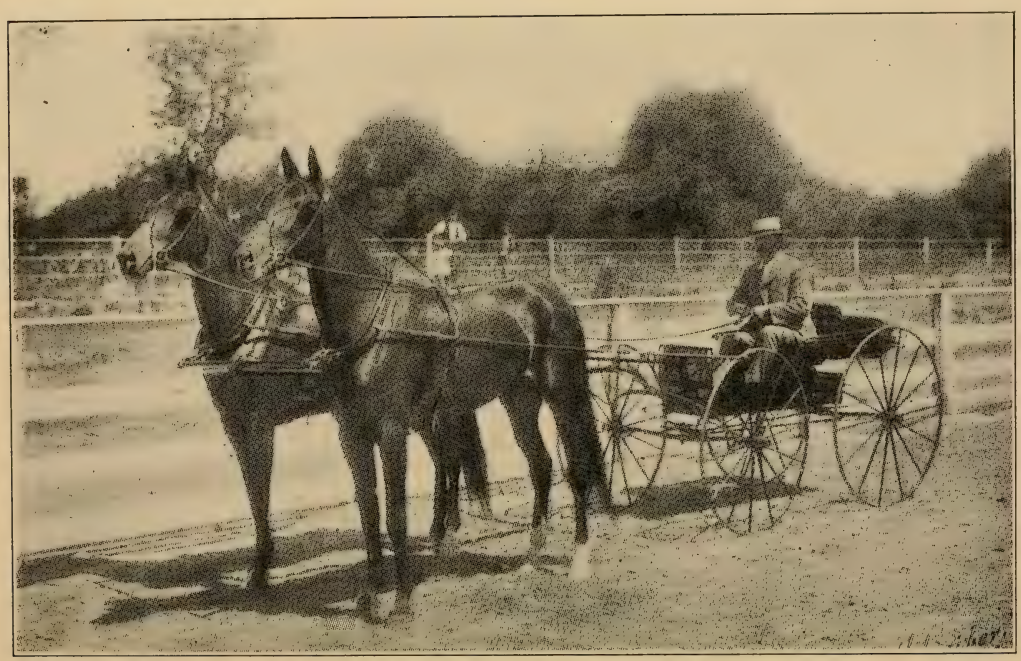


Fig. 44. Roadsters. By Courtesy of "Rider and Driver."

refinement about the head. His legs should be clean, with the tendons well defined. Many Roadsters lack size,—a point which has too often been sacrificed for speed. This class of horses is used both for pleasure and business. Road horses are almost all American Trotters.

The Saddle Horse. The saddle horse type is intermediate between the carriage and road classes. They show more quality than the carriage horse, and more symmetry than the Roadster. They are bred for riding, and the essential qualification consists in their ability to show the different gaits desired. The following gaits are considered standard for horses of this class: (1) Walk, (2) trot, (3) single foot, or rack, (4) canter, and (5) slow pace, running walk, or fox trot. Most saddle horses are derived from the American Saddle Horse and Thoroughbred breeds.

French Coach. The French Coach horse has been developed through the encouragement and direction of the French government. The typical French Coach horse is in all essentials a carriage horse. They stand about 16 hands high, and weigh 1,200 to 1,400 pounds. They stand rather high on legs, and are striking in appearance, as they carry their heads and tails high when in motion. They have a smooth and symmetrical appearance, as they are compact and closely ribbed. The hips are smooth and well covered, their quarters are strong and well muscled, and they have intelligent heads and graceful necks. The distinguishing characteristics of the

breed, as well as of all carriage breeds, is their high action. They should bring their knees up high, and have high and regular hock action. The common colors are brown, bay, and black, and these colors are generally solid, although many of them have some white markings. Many claim that they lack quality of bone, and that their joints are somewhat coarse and rough. They do not breed very true to type, as a rule. This is accounted for in the fact that so much alien blood was used in establishing the breed.

German Coach. The German Coach horse, as the name implies, is a native of Germany. The average of the breed stand about 16 hands high, and weigh from 1,200 to 1,400 pounds. They are either brown, bay, or black, and solid colors prevail. As to form, style, and action they resemble the French Coach to such an extent that, unless one is very familiar with both breeds, he will not be able to distinguish between individuals of each breed. The German Coach horse is somewhat larger and coarser, and does not possess as much quality, as the French Coach. Both breeds have been bred with the same type in mind, and as a result of this they do not differ greatly in appearance.

Hackney. England is the home of the Hackneys, where they have been bred pure for at least a century. They are one of the oldest carriage horse breeds. They are smaller than the French and German Coachers, being not over 15 hands 3 inches high, and weighing from 1,100 to 1,200 pounds.

They usually have solid colors, and are either bay or brown. The typical Hackney is extremely smooth, and has gracefully curved lines. The head is light and expressive, neck muscular and curved, but free from heaviness. Their bodies are cylindrical, compact, and short; and their quarters well muscled. Their legs are short, but of good quality, and the tendons are clearly defined. As a breed they cannot be surpassed in grace and style of action. The front legs are thrown very high, and the feet appear to follow the edge of a circle in their course. They flex their hocks well, and carry them far forward. Their attractive appearance and excessively high action are qualities that adapt them for city turnouts. As a breed, they have recently been very successful in winning prizes at the horse shows.

Cleveland Bay. The Cleveland Bay is a breed which takes its name from its native district in England. They are rangy, standing over 16 hands, and weighing from 1,300 to 1,500 pounds. The breed is very uniform in color, individuals being usually all bay, with black points. This is because they have been bred for years toward a uniformity of type. They have long, well-arched necks, short backs, and powerfully muscled hindquarters. They are one of the strongest breeds of light horses, but lack the style and action of the other carriage breeds. On account of their strong prepotency in color and type, they are valuable in crossing to produce matched teams of light farm horses.

The American Trotter. The American Trotter, as the name indicates, originated in the United States. The breed was established by the use of the Thoroughbred, and by care in selection and training for the trotting gait. They possess intelligent heads and light necks, low, deep chests, oblique shoulders, and long, muscular forearms. Their bodies are round, and light near the rear flank. They have long croups, full thighs, and bone of good quality. Their hocks are well defined, but often ill-shaped. They have been bred for endurance and speed at the trotting and pacing gaits, and size has frequently been sacrificed for fleetness, thus making them unfit for other than racing purposes. At the present time, more attention is being paid to size and style, and they are becoming better adapted for road use.

The Thoroughbred. This word is often, but incorrectly, used in place of the term "pure bred" to designate that an animal of a particular breed is eligible to registration. We have pure bred cattle, but no thoroughbred cattle. The Thoroughbred horse belongs to a distinct breed, and has been selected for excellence in running. They are even more refined than the American Trotter. They are deep in the chest, but light of body, with small, dense bone of the finest quality, and have every appearance of being built for speed. They have an active temperament, which is reflected in an erratic disposition. Their natural gait is running. Thoroughbreds have been used in improving all of the

breeds of light horses, and it is from this source that these strains get their active temperaments. Kentucky is the American home of this breed.

The American Saddle Horse. This breed was originated in the United States for the purpose of furnishing an easy riding and durable saddle horse. They were improved by the use of Thoroughbred blood, and by selecting for the qualities of a saddle horse. As a breed, they do not differ materially from the Trotter in appearance. They have more style about their heads and necks, and are larger and more muscular. They have a good quality of bone, and the tendons are well defined. They show a disposition to learn the saddle gaits readily,—a feature not characteristic of the Trotter or Thoroughbred.

THE DRAFT HORSE.

A horse that conforms to this type must be broad, massive, and muscular. It should have a quality of bone to sustain the weight. A typical draft horse weighs over 1,750 pounds at maturity. The majority fail to attain this weight, and are classified on the market as expressers. Draft horses are in great demand in the cities for heavy hauling. They are produced from the following breeds: The Percheron, Clydesdale, Shire, Belgian, and Suffolk Punch.

Percherons. The Percheron breed is a native of France. Horses of this breed were formerly called Norman, but this name is no longer used. The prevailing colors are black and gray. All Perch-

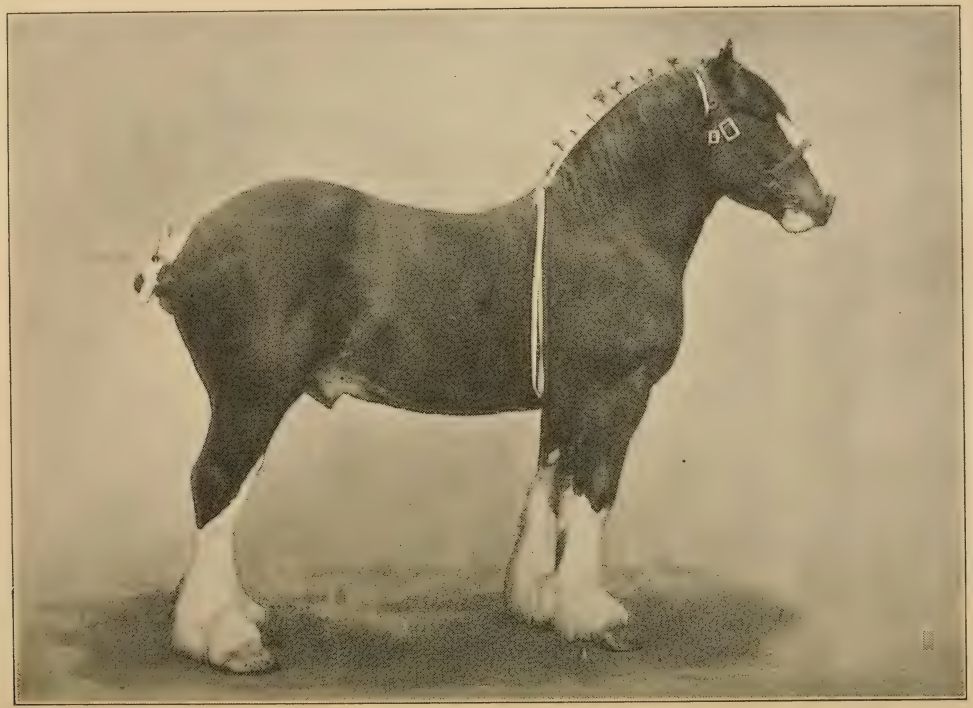


Fig. 45. Imported Clydesdale Stallion "Criterion" (11670) 11129. 1st prize winner as a two year old at the International 1903. Owned by W. L. Houser, Mondovi, Wis.

erons were originally gray, but at the present time the majority of them are black. The Percherons are active, and stylish about the head and neck. They have deep, broad, and massive bodies. Their legs are often too light, compared with their bodies. Their cannons are not wide enough, i. e., too round, and the pasterns are too short and straight in many representatives of the breed. They are a very popular draft breed with the farmer.

Clydesdales. The Clydesdale breed was developed in Scotland. They are usually brown, bay, black, or chestnut in color, with white markings. Hair springs from the back edges of their legs, and they are sometimes called "hairy legged horses." The head is usually intelligent, though sometimes out of proportion to the other parts of the body. The shoulders are sloping, giving the horse a free and easy action. The arm is well muscled, and the bone clean and flat, with a fine quality of hair springing from the edge of the cannon. The improvers of this breed have paid considerable attention to pasterns and hoofheads. They should have long, sloping pasterns and large hoofheads. Clydesdales often lack depth of body, and are frequently too long in the coupling. Because of their legs and their superior action, they rank high as a draft breed.

Shires. The Shires are native to England. They resemble the Clydesdales in many points, and expert judges may not be able to distinguish between them, providing the specimens of each breed inspected vary from the standard type. They have

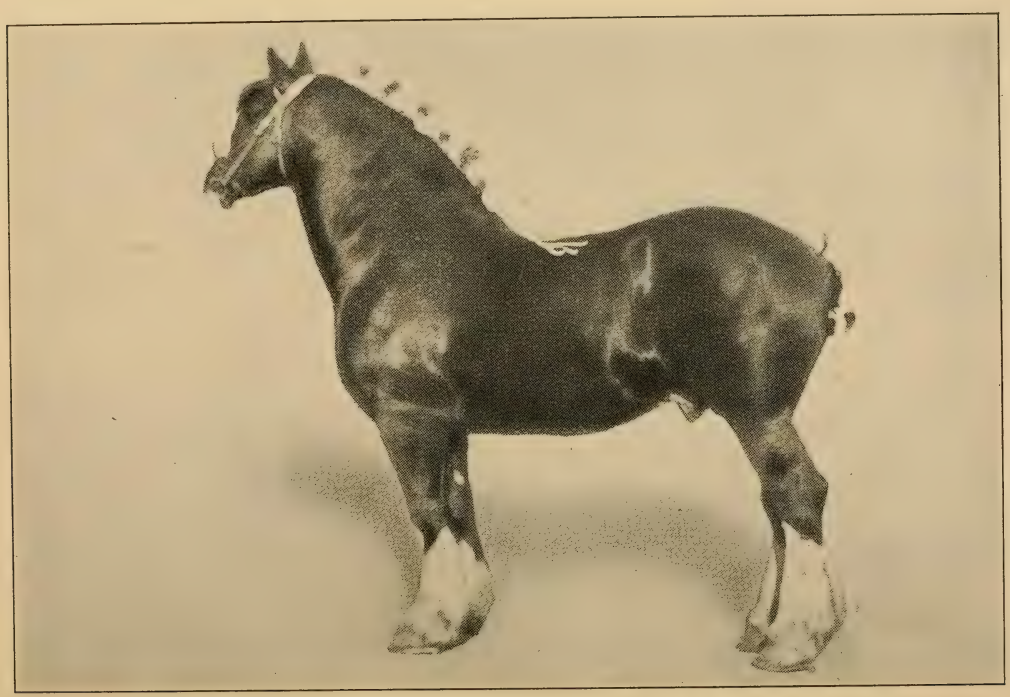


Fig. 46. Shire Stallion. Owned by Robert Burgess & Son, Wenona, Ill.

practically the same color markings as the Clydesdales. The Shires are very deep, wide, and massive in form. Their quarters are heavy and well muscled. They do not possess as good a quality of bone as the Clydesdale, but they are also known as a "hairy legged" breed. The hair tends to spring out around the leg, rather than from the edge of the Cannon bone, as is the case with the Clydesdales. The Shires may be criticised for the coarseness of their bones, for their short stubby pasterns and stilted action, and also for possessing a somewhat sluggish temperament.

The Belgian Horse. The Belgian breed, as the name indicates, is native to Belgium. They are of various colors; bay, brown, sorrel, and roan predominate, but they are free from white markings. They have very neat heads, and well-muscled, high, and short-crested necks. Their bodies are wide, short and compact, appearing somewhat cylindrical in shape. They have well-muscled quarters and croups, but they often tend to be too sloping in the croups. The bone resembles the bone of the Percheron in many respects, being rather light for their body. The pasterns are not long and sloping enough, and the feet are rather small, and not of good quality.

The Suffolk Punch. The Suffolk Punch is a British breed of horses, and has been bred so that it is exceptionally uniform in type. It is an old and well-established breed. They are chestnut in color, and the best representatives are deep bodied and

short legged. Their bone is of medium size, but it is clean and of good quality. They have a reputation for docile temperaments, and are steady workers. Many of them lack size, and are less adapted to heavy draft than to farm work. They resemble the Percherons in form, but they are lighter in weight. Their bone is of a much better quality than that of the Percheron.

CHAPTER XVII.

SHEEP.

Origin and History. The origin of sheep is not definitely known. Sheep were domesticated in Asia and Europe before the dawn of history. They were unknown in America until after its discovery by Europeans. Sheep were introduced into North America by the Spaniards as early as the beginning of the sixteenth century, and sheep of British origin were introduced into nearly all the English colonies very soon after their settlement.

Classification. Sheep are sometimes classified as heavy breeds, down breeds, and mountain breeds, but it is more common to classify them with reference to the character of their wool. On the basis of wool production, they are classified as fine wooled, medium wooled, and coarse wooled. The following are the fine wooled breeds in the order of the fineness of their wool, beginning with the finest. The American Merino, Delaine Merino, and Rambouillet. The following are the medium wooled breeds in the order of the fineness of their wool, beginning with the finest: Southdown, Tunis, Dorset, Shropshire, Cheviot, Suffolk Down, Hampshire Down, and Oxford Down. The following are the coarse wooled breeds in the order of the fineness of their wool, be-

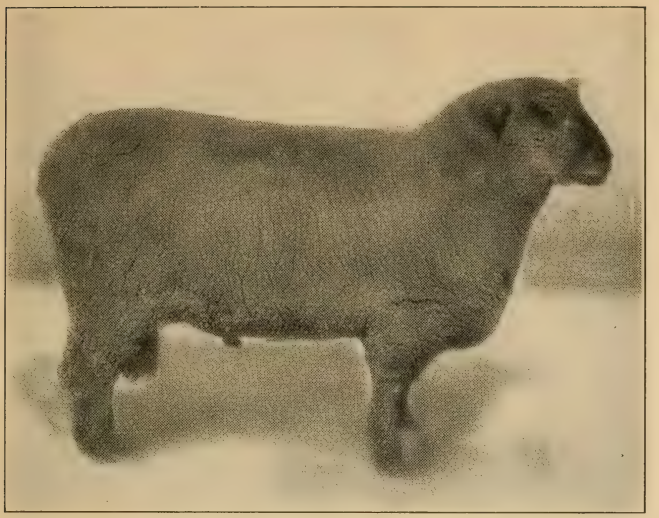


Fig. 47. Yearling Southdown Ram "Knowlton Hero;" Champion at the World's Fair and International 1904. Owned by Geo. McKerrow & Sons, Pewaukee, Wis.

Fig. 48. Two Year Old Oxford Ram "Kelmscotonian 51." 1st prize in 1904 at World's Fair and International. Owned by Geo. McKerrow & Sons, Pewaukee, Wis.

ginning with the finest: Leicester, Lincoln, and Cotswold.

Rambouillet. (1) Origin and History. Rambouillets are descended from the Spanish Merino.

Fig. 49. Shearing Sheep by Machine at the North Dakota Agricultural College.

Their improvement has been made chiefly in France, and by reason of that fact they are often spoken of as the French Merino. They are very popular on the western ranges of America, are found in nearly all the northern and middle states, and are meeting with some favor in the southern states.

(2) General Appearance. The Rambouillets are large, somewhat rangy sheep, and not so wrinkled as the American Merino. They have more of the mutton form than the American Merino or the Delaine Merino, but their fleece is less dense.

(3) Adaptability. Rambouillets are adapted to a wide variation in soil and climate. They do very well on rich land, where the pasture is good, and

Fig. 50. Rambouillet Ram. Bred and owned by the North Dakota Agricultural College.

are well adapted to range conditions, where the vegetation is not too scanty. If well fed they fatten in good form.

(4) Meat. The quality of the meat is good, but not equal to that of the Southdown and other strictly mutton breeds.

(5) Wool. Their wool is longer and coarser than that of the American Merino, but the average weight of the fleece is not so heavy.

Southdown. (1) Origin and History. The Southdown is a British breed. Their improvement dates back to the year 1776, which makes them one of the oldest breeds. They are very popular in the United States and Canada.

(2) General Appearance. The Southdowns are the smallest of the medium wooled breeds in America. They are low set and compact, weighing remarkably well for their size. Many of them are the ideal type of the mutton sheep. They have no horns, and their faces are brown or gray in color. The head is well wooled, but is not covered below the eyes.

(3) Adaptability. Southdowns are adapted to rolling and hilly lands, where the pastures have a short, fine herbage.

(4) Meat and Wool. The meat of the Southdown ranks higher in quality than that of any other breed. They shear a rather light fleece of wool, which probably does not average heavier than five to seven pounds.

Shropshire. (1) Origin and History. The Shropshire is also a British breed. They are descended from the common sheep of England. The Southdown, Cotswold, and Leicester breeds were used in improving them. They are one of the most popular breeds of sheep in America.

(2) General Appearance. The Shropshires are considerably taller and longer than the Southdowns, and somewhat heavier. They have black faces and

Fig. 51. Yearling Lincoln Ram. Owned by the University of Minnesota.

no horns. Their heads and faces should be covered with wool.

(3) Adaptability. They are not particularly adapted to mountainous regions, but are reared extensively in the fertile sections of the United States. They graze fairly well, but require richer pastures than either the Southdown or the Merino.

(4) Meat and Wool. The quality of their meat is nearly equal to that of the Southdown, and they furnish a larger quantity. They dress well in proportion to their live weight. Their wool is coarser than that of the Southdown, and the fleece is somewhat heavier. The average weight of the fleece is nine or ten pounds.

Lincoln. (1) Origin and History. The Lincoln is one of the coarse wooled breeds. It originated in England. The Lincolns are descended from an old English breed which has carried that name for many years. The Leicester breed was used in improving the Lincoln, but their greatest improvement came through proper care and selection.

(2) General Appearance. The Lincolns have large, massive forms. They are the heaviest of all the breeds of sheep, their weight ranging from two hundred twenty-five to three hundred pounds. They have white faces and legs, and are free from wool on these parts.

(3) Adaptability. The Lincolns are adapted to low, level lands, where the pastures are good, and where plenty of grass can be produced.

(4) Meat and Wool. They furnish a large amount of meat, which is of fairly good quality, but not equal to that of the Southdown. Their fleeces are long and coarse, and weigh from twelve to fourteen pounds.

CHAPTER XVIII.

SWINE.

Origin and History. Swine were found in a wild state on every continent except Australia. They have been domesticated in the old world since prehistoric times. Most of the breeds originated in Great Britain and the United States.

Classification. Swine are classified on the basis of color, bacon producing qualities, and size. With reference to their size they are classified as large, medium, and small. The following are the large breeds in the order of their size, beginning with the largest: Chester White, Improved Yorkshire, and Tamworth. The following are the medium breeds in the order of their size, beginning with the largest: Berkshire, Poland China, Victoria, Duroc Jersey, and Cheshire. The following are the small breeds in the order of their size, beginning with the largest: Suffolk, Essex, and Small Yorkshire. The red breeds are the Tamworth and Duroc Jersey. The black breeds are the Poland China, Berkshire, and Essex. The remaining ones are white.

Chester White. The Chester Whites originated in Pennsylvania, and are now widely distributed in the United States and Canada. They are probably the largest of all the breeds of hogs. As their name

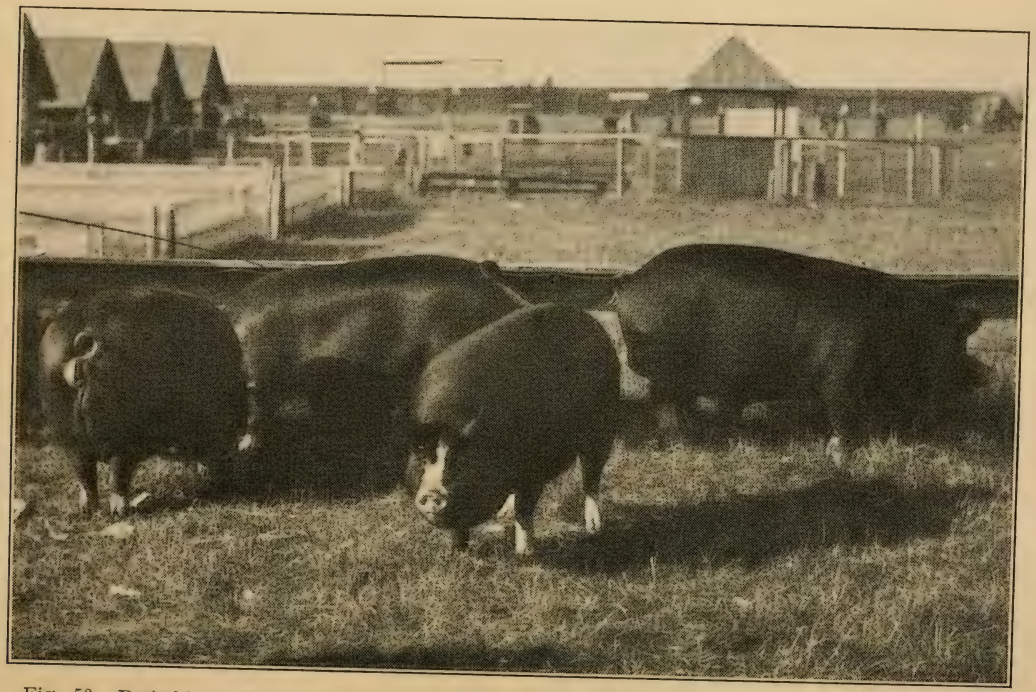


Fig. 52. Berkshires. Prize winning young herd. Bred by A. J. Lovejoy & Son, Roscoe, Ill.

indicates, their color is white. Their meat is of good quality, but they do not dress as large a percentage as some breeds, because they are somewhat coarse boned. This breed is quite prolific.

Berkshires. The Berkshire is a British breed, and is very popular, not only in Great Britain, but in the United States and Canada. They are about the size of the Poland China, but are longer bodied. Their color is black, but they have white on the legs, a splash of white in their face, and white tail tips. They have a short, dished face and a fine upstanding ear. The quality of meat is good, and they dress well in proportion to their live weight.

Poland Chinas. The Poland China breed originated in Ohio. In the western and northwestern states they are more popular than any other breed. They mature very young, fatten readily at almost any age, and their meat usually contains a large amount of fat in proportion to the lean. Their color is nearly like that of the Berkshire, but they are more compact in form, and have drooping ears.

Duroc Jerseys. This breed originated in New York and New Jersey, and is gaining in popularity throughout the United States. Duroc Jerseys are red in color, and in form they resemble the Poland Chinas. They are probably a little coarser in bone than the Poland Chinas.

Large Improved Yorkshires. The Large Improved Yorkshire was introduced into this country from England. They are of the bacon type, and are

strong boned and long bodied. The meat is excellent in quality. They are bred extensively in Canada and the northwest, where less corn is fed than in the corn belt. Their color is white, and the face dished.

CHAPTER XIX.

PLANT AND ANIMAL BREEDING.

Heredity. The expressions "like produces like" and "a chip out of the old block" are older than human history, and indicate that people living centuries ago recognized the subtle principle of heredity as one of the laws of the universe. This law has more commonly been regarded as applicable to the animal world and to the human family, but the expression: "Do men gather grapes from thorns or figs from thistles?" indicates that people living twenty centuries ago applied the principle to plant production. Fife seed wheat produces Fife plants, Blue Stem seed produces Blue Stem plants, while Durum or Macaroni seed wheat always produces that heavily bearded sort. The hereditary principle has been found to apply to three classes of traits in animals: (1) Ordinary or natural characters or traits; (2) acquired characters or traits; (3) abnormal characters or traits.

(1) Natural Traits. Natural traits are represented by such features as size, form, and color in plants and animals, and by complexion and peculiarities of mind in men. Examples are, light and dark complexioned families, families of athletes, families of musicians, families of orators, and so on,

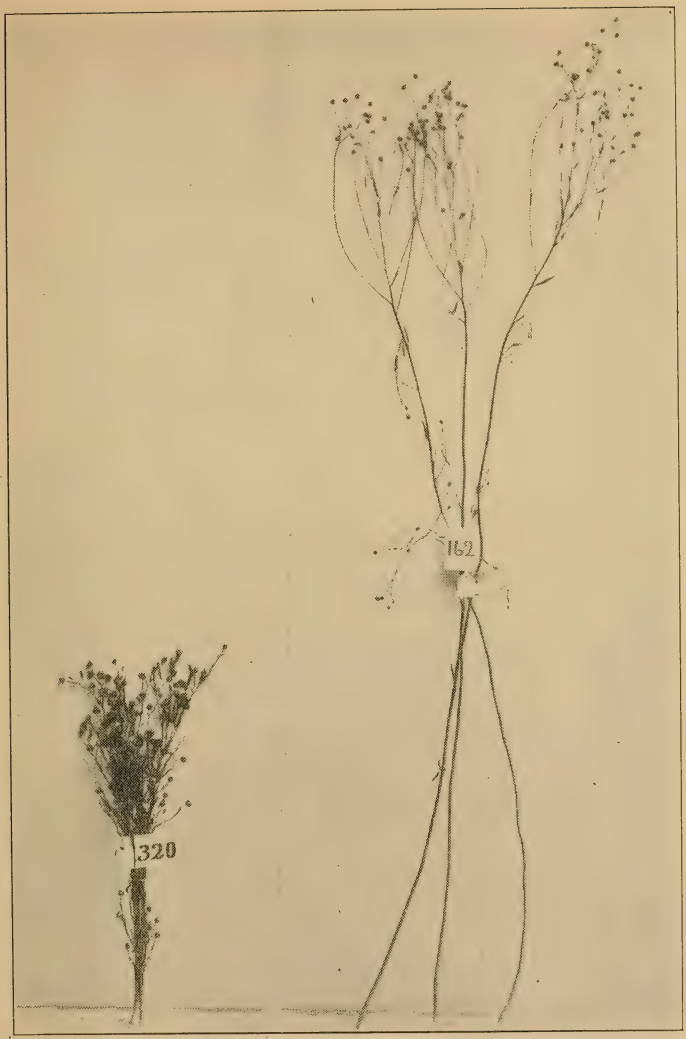


Fig. 53. Samples of Flax. From a photograph showing the extremes in length of flax produced in the North Dakota Experiment Station Nursery of Plant Breeding. Flax samples, 320 and 162, each consist of three representative plants, and each plant has sixteen square inches of soil to grow in.

(2) Acquired Traits. Acquired traits are those which men and animals learn and later transmit to their offspring. Examples are, the setting of birds by bird dogs, the herding of stock by shepherd dogs, and the gait of the trotting horse. The wild ancestors of these animals had none of the habits which their progeny have since learned, and now regularly inherit.

(3) Abnormal Traits. Examples of abnormal traits are represented by the following: A white lock of hair on a dark head, hare lips, and the fan-tailed breeds of pigeons.

Atavism. An offspring frequently resembles a grandparent or some ancestor even more remote. This principle has been recognized for centuries, and common experience teaches that it can regularly be traced back four and five, and occasionally for ten or more generations.

Variation. This is the third general law of heredity. The first law proclaims that like produces like. The second (avatism) that this law or principle may allow grandparents, great-grandparents and great-great-grandparents partially to govern the appearance of their offspring. The third principle (variation) virtually says like produces unlike. A moment's thought will convince every observing person that each of these propositions is correct. Like produces like, but not quite alike. White men resemble each other more than they do Chinamen; and yet among your acquaintances, numbering hundreds of white persons, you can call each by name, and make no mistake as to his identity. Calves look

alike, colts resemble each other, wheat plants are similar in appearance; but any one can soon learn to distinguish one from the other. If they were exactly alike, that would be impossible. The fact or law of variation brings constant differences,—a fact which allows the breeder to select the individual which has varied from its family type in the desired direction. The law that like produces like allows the breeder to fix the type in a few generations so that it will be reproduced.

Pedigrees. The dictionary definition of a pedigree states that it is the history of the ancestors of an animal. Stock men generally require a pedigree to guarantee that the animal is a pure bred, and a recognized individual of an established breed. If the law of atavism is to be considered by the breeder, the pedigree, as a description of the ancestors, must form the basis for his judgment. The pedigree guarantees to the breeder that his animal is pure in blood, and that its offspring may resemble its remote ancestry, and still be high-class individuals of the breed and family which he is keeping.

The Practices of Animal Breeding. Live-stock breeders follow many rules which are based upon their experience, and, while they are important, it is not within the province of this book to discuss them. Such practices as cross breeding, in and in breeding, line breeding, and grade breeding have been studied until fairly stable laws of cause and effect have been worked out. The number of pure bred animals in the world is too scarce to supply the demand for

meat, dairy, and work producing stock, hence grade animals must constitute the flocks and herds of the world for many years to come. By reason of the governing principles or laws given in this chapter, pure bred sires only should be used, as they govern the valuable features in animal production much more closely than grade parents can do. Choose among the breeds which are adapted to the purpose for which you propose to keep live stock. If you want to grow beef cattle, for example, choose among Shorthorns, Herefords, Aberdeen Angus, and Galloways. If you want a dual or general purpose herd, choose the dual purpose breed best adapted to your conditions. When you have settled upon a breed, stick to it unless you find that you have made a decided mistake. As soon as your herd is large enough to warrant cutting down, cull out the poorer individuals, so that your herd or flock will constantly improve.

The Practices of Plant Breeders. Select the variety of wheat, oats, barley, or other class of plants which suits your conditions; for example, Fife, Blue Stem, or Durum wheat. When a variety has been decided upon, get the best strain of it for your section of country which can be found. Get one which has given a good grade and a good yield for as many generations as possible. See the field that your seed grain is to come from if you can possibly do so, as there you can learn whether the plants are uniform, the height they attain, the stiffness of straw, how the chaff holds, and many other points which cannot

Fig. 54. Three different types of flax plants. Produced by the breeding work of the North Dakota Experiment Station. All of the plants were given the same growth conditions and treatment.

be gleaned from an inspection of the cleaned grain. Corn selected in the field allows the use of judgment upon the entire plant, and not upon the ear alone. Many a good ear of corn is borne so low upon the stalk as to lack value when compared with other ears of similar form, size, weight, and proportion. After ears of seed corn have been chosen from the field, sort them over, throwing out the poorer ones, until a uniformly high-grade sample remains. Wheat, oats, barley, and flax should be run through a fanning mill until the smaller and lighter kernels are removed, as that will leave the largest and heaviest kernels from the best plants. Wheat, oats, or barley seed, thrown twenty feet or more from the open palm, will be graded to quite an extent by the distance which it will carry, as the heavier kernels will fly considerably farther than the lighter ones. This operation, carried out upon the barn floor, has a decided selective advantage, and will well repay the owner for his trouble.

CHAPTER XX.

FEEDS AND FEEDING.

Animal life is dependent either directly or indirectly upon plant life for its food. Some kinds of plants are particularly adapted to nourish a certain class of animals, just as some kinds of soil are adapted to produce certain plants. The reason why all plants and the feeds derived from them are not suitable to feed all classes of animals is largely because the digestive tracts differ materially.

The Mouth. Horses and hogs have teeth on both the upper and lower jaw. Cattle and sheep have forward or incisor teeth on the lower jaw only.

Digestion in the Mouth. It is in the mouth that the first process of digestion takes place. The food is reduced to fineness by the molar teeth, with the assistance of the lips and tongue. It is at the same time thoroughly mixed with saliva, which is secreted by the salivary glands located in the walls of the mouth cavity. This alkaline secretion changes the starch and woody fiber of the food into sugar, and what remains is acted on farther along in the digestive tract.

Stomach. The stomachs of farm animals differ in form, capacity, and function within certain limits.

The stomach of a cow of ordinary size holds more than two barrels. The stomach of the cow is in size about eight times that of the sheep, fourteen times that of the horse, and thirty-one times that of the hog. This is why the cow can eat so much more roughage than the horse. Horses and hogs have single stomachs, while the stomachs of cows and sheep are divided into four compartments. These are known as the first, second, third, and fourth stomachs, respectively. Starch and woody fiber are digested from the time the food is moistened in the mouth until it reaches the fourth stomach. The first three stomachs really perform much the same office as the mouth. The first stomach of cattle and sheep is simply a large sack into which the half-chewed food is dropped. This food is returned to the mouth for a second chewing. The second stomach is used as a sort of "catch all" for gravel, pieces of nails, etc., which would injure the walls of the other stomachs. It has a very thick wall, and really has little part in digestion. The third stomach receives the finely chewed food which is swallowed after the second chewing. This stomach has a great number of folds, so that the food is rubbed considerably by its walls. It is in the fourth stomach that the protein is digested.

Digestion in the Stomach. The important work that takes place in the stomach is that performed by the gastric juice, which is secreted by the gastric glands. The gastric juice is acid, and has the ability to change proteid substances into a soluble form.

Digestion in the Intestines. The food passes from

the stomach into the intestines, where it is mixed with the bile and pancreatic juice. These act on the fatty portions of the food, which they change into an emulsion that readily passes through the walls of the intestines to be distributed to all parts of the body.

Digestibility of Food. Foods differ much, not only in their chemical composition, but in their digestibility. Some of the things that most commonly affect the digestibility of feeding stuffs are: Palatability, degree of ripeness, wetting, soaking, cooking, grinding, and curing.

Palatability. Palatability, or an agreeable taste, causes more effective digestion by increasing the flow of saliva and other digestive juices. An animal will eat more, and grow faster, if its food is clean and has an agreeable taste.

Wetting. Wetting or moistening food has little effect upon its digestibility, except when it causes more thorough chewing of the food eaten. Shorts or meal, when moistened, become more palatable for hogs; but in a number of Experiment Station trials, cows fed ground wheat and bran in slop gave less milk and butter than those fed dry food of the same kind and quantity.

Soaking Feed. Corn sometimes becomes so hard and flinty several months after husking that it is hard for animals to chew it well. Under such circumstances it is benefited by soaking; otherwise not. In soaking grain, care should be taken not to allow it to sour, as souring always results in a loss of starch and sugar from the food. Barley, wheat, and rye

can usually be soaked for hogs to advantage, probably because it enables them to chew it better.

Cooking Feed. About fifty years ago, a number of stockmen put in systems for cooking and steaming feed for cattle, but the practice is not common today. Trials by chemists show that it makes the most valuable part of the hay (protein) less digestible to steam or cook it. Potatoes should be cooked for hogs. For horses, cooked food once a week or a little oftener, tends to keep their bowels open, and the animal in good thrift. Cooking feed for them daily is not advisable, however. Cooked food is good in this half-medicinal way for all classes of animals, as an occasional ration.

Grinding Grain. Only animals with poor teeth, or those worked extremely hard, such as the hard-worked horse and the heavy-milking cow, need their feed ground. Hogs and fatting steers can be crowded a little faster with ground feed. Trials with seventy pigs in feeding whole corn as compared with cornmeal show that four hundred and fifty-nine pounds of cornmeal and middlings equaled four hundred and ninety-nine pounds of whole corn and middlings, or a saving of eight per cent. from grinding. Corn and cob ground together gave almost as good results for the corn and cob weights as for pure cornmeal.

Curing Hay and Fodder. Trials show that grass dried without rain or dew and without heating is just as digestible as it was when green. There is often a heavy loss from the rain washing out the most valuable and digestible portions, and from heating and

molding. Sometimes the leaves break up, rattle off, and blow away, which causes a great loss in weight, and also a loss of the most digestible portion of the food.

Degree of Ripeness. The hay grasses become less digestible from the time of blossoming until fully ripe, partly because of the increase of woody fiber, and partly because of poorer flavor. Indian corn, on the contrary, becomes more digestible as it ripens. The following table shows the amount of water and dry matter in a corn crop at different periods after tasseling:

Date of Cutting	Stage of Growth	Corn per Acre, Tons	Water per Acre, Tons	Dry Matter per Acre, Tons
July 30	Fully tasseled.....	9.00	8.2	.8
Aug. 9	Fully silked.....	12.9	11.5	1.5
Aug. 21	Kernels watery to full milk.....	16.3	14.0	2.3
Sept. 7	Kernels glazing...	16.1	12.5	3.6
Sept. 23	Ripe.....	14.2	10.2	4.0

From the above table, which represents a trial made by Professor Ladd, of the North Dakota Station, it will be seen that corn which had silked had practically twice as much dry matter per acre as it had when first tasseled. When in the milk, it contained almost three times as much dry matter as when in the tassel. When glazing, it had more than four times as much dry matter per acre as it had when it was tasseled. When ripe, it contained just five times as much dry matter as it did when in the tasseling stage.

Corn Fodder and Stover. It is common to speak

of the corn stalk, from which the ear has been removed, as corn stover. When the ear is included, it is called corn fodder. Both are valuable for feeding stock. When stover is fed, it will usually be found advisable to feed some concentrated food.

Forage Crops. A forage crop is a crop that is allowed to grow for a considerable length of time before pasturing. It is usually allowed to approach maturity before being used for pasture. Among our best forage crops are: Indian corn, sorghum, clover, peas, rape, oats, and millet. The following is a very good combination to sow as a forage crop for hogs: Two bushels of oats, one bushel of peas, and two pounds of rape seed.

Soiling Crops. A soiling crop is one that is allowed to grow for a time, usually until nearing maturity, at which time it is cut and fed to live stock. Indian corn, peas, and rape make good soiling crops.

Ensilage. When a crop is cut green and stored in a silo, it is called ensilage or silage. Corn is used for ensilage more than any other crop. A silo is usually a tall, strong building, made of brick, stone, or wood, and having air-tight walls. The corn is cut fine, and packed so close in the silo that air does not penetrate readily more than a foot beneath the surface. Ensilage sours some, but does not decay if the conditions are right. If the corn is cut too green, it should be allowed to wilt before being put into the silo. If this is not done, the ensilage is likely to be too sour. On the other hand, when the corn is not cut until almost ripe, it is well to sprinkle

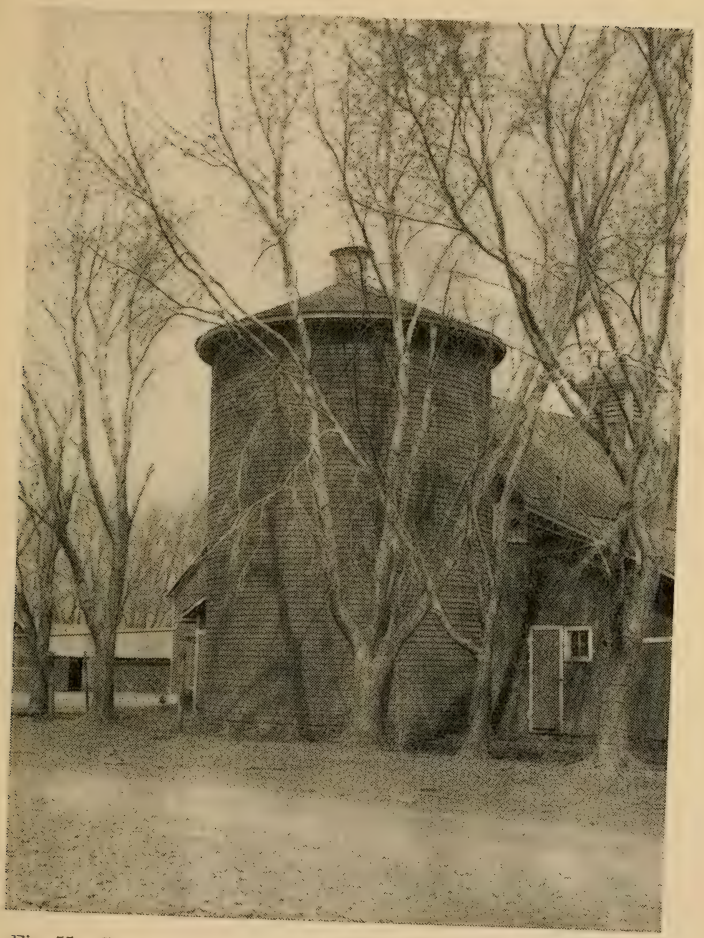


Fig. 55. Silo. On the farm of A. T. Budlong, Glenville, Minn.

it with water as it is being placed in the pit, otherwise it may rot. Ensilage is an excellent feed for

Fig. 56. Cattle Barn and Silo. At the North Dakota Agricultural College.

dairy cows. For other classes of live stock it may not pay to build a silo.

Medicinal Stock Foods. There are many brands of condimental* stock food on the market, which are advertised as wonders in the way of keeping animals in good health and causing them to fatten. These foods are always sold at a high price as compared with ordinary feed, and those who have investigated the matter say that they have no special merit for feeding healthy live stock. Most of the so-called stock foods are simply good food, sold at a very high price.

*See pages 229 and 230 of "Feeds and Feeding," by W. A. Henry.

Kinds of Material in Feed. The important constituents in feed from the standpoint of the feeder are protein, carbohydrates, and fat or ether extract.

(1) Protein. Protein is the part of the food which is used by the animal in forming muscle, ligaments, hair, skin, and the cheesy part of milk, and it can be used to keep the animal warm, to do work, and to produce fat. The white of an egg, lean meat, and the gluten of wheat are examples of almost a pure protein.

(2) Carbohydrates. Carbohydrates consist of starch, sugar, and the digestible woody fiber of plants. Carbohydrates can be used by the animal to keep him warm, to do work, and to form fat.

(3) Fat or Ether Extract. Fat in food can form fat in the animal, it can be used as fuel to keep him warm, or it can be used to produce work. Fat is used for the same purposes by the animal as are the carbohydrates, but its feeding value per pound is considered to be two and two-fifths times that of starch. When a pound of oil is burned for fuel, it produces two and two-fifths times as much heat as a pound of sugar or a pound of woody fiber.

Balanced Rations. Protein, carbohydrates, and ether extract occur in all food substances, but in different proportions, and the amount which is digestible differs in different food substances, which facts cause the difference in value of the different grain and forage materials used by the feeder. Of these three digestible materials, protein is the most expensive, and is necessary in every ration. No muscle can be formed or repaired without it. Hair, wool,

skin, hoofs, nails, and feathers are all formed largely from protein, and cannot be made by the animal without this material. For feeding animals, there are right proportions of the three digestible substances,—protein, carbohydrates, and fat. The ratio is narrow when there is a small relative amount of fat and carbohydrates to protein. When the reverse is true, the ratio is wide. One pound of protein to five of carbohydrates and fat is quite a narrow ratio; and one pound of protein to ten or twelve of carbohydrates and fat is a wide ratio. In figuring the ratio, the pounds of fat are multiplied by two and four-tenths, and added to the carbohydrates. The reason for this is explained above. Milch cows, fattening stock, and work horses do best on a narrow ratio, and stock that is not being fattened or worked may be fed a wide ratio. This is shown in the following table, which gives the results of actual trials:

FEEDING STUFFS	Dry Matter, Lbs.	Digestible Protein, Lbs.	Digestible Carbohydrates, Lbs.	Digestible Ether Extract, Lbs.	Nutritive Ratio
Ox at complete rest in stall	18.0	0.7	8.0	0.1	1:11.8
Fattening cattle (first period)	30.0	2.5	15.0	0.5	1:6.5
Milch cow (yielding 22 lbs. daily)	29.0	2.5	13.0	0.5	1:5.7
Horse (medium work)	24.0	2.0	11.0	0.6	1:6.2

In order to furnish any of these nutrients in the amounts given in the table, it is necessary to use several kinds of feed.

The following table shows a ration worked out

for the rapid fattening of a steer during the first feeding period (weight 1,000 lbs.):

FEEDING STUFFS	Dry Matter, Lbs.	Digestible Protein, Lbs.	Digestible Carbohydrates, Lbs.	Digestible Ether Extract, Lbs.	Nutritive Ratio
Corn stover, 10 lbs	5.95	.17	3.24	.07	
Oat straw, 8 lbs	7.26	.10	3.09	.06	
Corn, 12 lbs	10.73	.94	8.00	.52	
Oil meal, 4 lbs	3.63	1.17	1.31	.28	
Trial ration	27.57	2.38	15.64	.93	1:7.5
Wolff-Lehmann Standard.	30.00	2.5	15.0	.50	1:6.5

The ration worked out above corresponds very closely with the Wolff-Lehmann standard in the most important nutrients,—protein and carbohydrates. In order to work out a ration it is necessary to have at hand a table giving the digestible nutrients of the different feeds. Space will not permit the insertion of such a table in this book, but it can be found in such books as Henry's "Feeds and Feeding," and Jordan's "The Feeding of Animals."

The standard requirements have been worked out experimentally, and they serve as guides, but it would be impracticable to follow them absolutely. The farmer is obliged to use his judgment in practical feeding. The price at which the different feed stuffs can be bought in different localities and at different times must be taken into consideration in working out a ration that can be fed economically. As a rule, the narrow ratio includes feeds that are more expensive than those used in the wide ratio.

CHAPTER XXI.

CARE AND MANAGEMENT OF LIVE STOCK.

Why Good Care Is Necessary. While care and management are prerequisites in all branches of agriculture, they are perhaps nowhere so essential as in stock raising. Farm animals are entirely dependent on the provisions made for them by man, and, in the course of domestication, they have largely lost those qualities which enabled their ancestors to survive under adverse conditions. Successful stock growing involves the principles by which animals are maintained in good condition, and all those by which animal production can be made profitable.

Sanitary Feeding. Food which has nutritive value may be possessed of other qualities which render it unfit for use. Good food should be free from foreign material. Hay must be well cured and free from molds to be wholesome. Molds are the cause of "musty" hay. Such hay is not palatable, and the molds and fungi in it are often poisonous. Horses are especially liable to become diseased after eating moldy feed. Hay should also be free from dust, as the breathing in of the dust particles is apt to irritate the air passages of the animals. The feeder should be alert to avoid poisonous plants in the forage given to his stock.

Feeding Grain. Overfeeding and the feeding of unripe grain should be avoided. Immature grain is hard to digest, and too much grain overworks the digestive system. Digested food retained in the alimentary tract as a result of overfeeding will undergo fermentation, which process is often followed by digestive disturbances of the most serious nature.

Pasture. Especial care should be exercised when cattle and sheep are turned on rape, green clover, and alfalfa pastures. The feeding of even moderate quantities of these foodstuffs is apt to produce a condition known as bloat, which is caused by the rapid fermentation of the forage in the first compartment of the stomach. Such accidents are more apt to occur when animals accustomed to a dry diet are suddenly turned into pasture, and when they are turned upon such pasture after a dew or a rain. When such forage crops are to be used, it is advisable to make the change from dry to green food a gradual one.

Daily Ration. The daily ration of food should be given to live stock in two or more feeds, in order to obtain the best digestion. If all the food is given at one meal, the stomach is apt to become overloaded, and some of the food may pass on without being digested at all. Three meals a day is perhaps the most advisable distribution of the daily food supply. In fattening animals, however, food is often kept before them continually without apparent bad results, but the waste of material in such cases is considerable. Care should be exercised in giving concentrated food stuffs to horses when they are tired.

Severe muscular effort naturally brings about more or less depression of some of the vital functions, and gastric depression may participate in this to such an extent as to cause the stomach to be unable to perform its work in the usual manner. It is always better to feed a tired horse its hay ration first, and postpone the grain feeding until rest has restored the vital activity of the digestive apparatus.

Water. As seventy per cent. of the animal body is composed of water, all kinds of stock should have constant access to it. Water is important, not only as a component part of the body, but it is also the medium of exchange by which the process of life known as metabolism is made possible. No pains should be spared to provide animals with pure water. Good water should be clean, colorless, free from odor, and soft or very moderately hard. It should not be contaminated with sewage or stable drainage,—in fact there should be a total absence of organic material. Contagious diseases are often transmitted through the water supply, and, when such diseases occur, special care should be exercised to prevent the contamination of the drinking water.

In a number of parasitic diseases the trouble can be traced to the water, as the eggs and embryos of parasites are apt to contaminate it. Liver flukes in cattle and sheep, and the tapeworm disease of sheep, are very commonly transmitted by means of the drinking water. Immature parasitic forms frequently inhabit ponds of stagnant water, and hay

collected from the vicinity of such pools should be looked upon with suspicion.

Time of Watering. The best practice is to allow animals access to water at all times. In the case of working horses, such a plan is impracticable, but water should be offered to them at regular intervals. Horses are usually watered at meal times, and the question has been asked: "Must horses be watered before or after eating?" Experience has taught that it makes little difference when water is given, especially when the animals become accustomed to a certain manner of watering. To the writers, it seems advisable to offer water before as well as after eating; but when a horse is fed on a heavy ration of food which will ferment easily, some time should elapse after feeding before water is given. During cold weather, water of too low a temperature should be avoided; and in watering horses when they are hot from hard work, care should be taken to prevent them from overloading their digestive tracts with cold water, as this frequently injures the animal.

Salt. Another necessity to animal life is a supply of salt. Most food stuffs contain a certain percentage of this substance, especially those which are grown on a soil containing salt in large proportion. In many food stuffs the percentage of salt is not sufficient, and the attendant is forced to provide salt for the live stock aside from their regular diet. This is best done by giving them access to pieces of rock salt. Salt may be placed in the feeding trough or in the pastures, that the animals may avail them-

selves of it whenever they feel inclined to do so. Besides being an absolute necessity to the body economy, salt constitutes a condiment which enlivens the appetite, stimulates the secretions, and preserves a desirable condition of the bowels.

Care of Stable. Next in importance to the food and water supply comes the stable and its care. Stables should be built on sites which have a good natural drainage, and, where this is impossible, on land which has artificial drainage. Stable drainage is a prerequisite for good sanitary conditions, and should always be the first consideration in building barns, corrals, and other structures for the care of live stock.

Drainage and Ventilation of Stable. The floors of the stable should always be some distance above the ground, water tight, and provided with gutters to carry off the liquid excrement. There should be ample air space in every stable, and the air contained therein should be kept pure by a constant exchange with the fresh air from outside. Tuberculosis is much more prevalent among animals housed in close and ill-ventilated stables than it is where an abundant supply of fresh air is provided. This disease is seldom found in cattle that live continually in the open air. A stable should have plenty of windows which admit direct sunlight, as this is an important factor in the destruction of harmful bacteria.

Cleanliness. In caring for a stable, cleanliness must always be given first consideration, the soiled

bedding and droppings of the animals should be removed daily, as their decomposition gives rise to harmful gases, while their presence is by no means conducive to sanitary conditions. Cleanliness should not be confined to the stable floor, as the mangers and feed boxes should also be cleaned regularly. It will be found advantageous to construct the latter so that they may be removed occasionally, to make a thorough cleaning possible. Cleanliness in animal quarters is of great importance, and it should always be applied to the hog pens, as well as to horse and cattle stables. The idea that swine thrive better among filthy surroundings is highly erroneous. Hogs kept under clean and sanitary conditions are less liable to disease, and are more thrifty, than when the surroundings are filthy. In managing poultry houses, special attention should be paid to keeping the premises free from the parasites which infest domestic fowls, and which frequently make poultry raising highly unprofitable. This is best accomplished by the frequent removal of old litter, and by an occasional application of whitewash which contains some disinfectant.

Cleanliness of Animals. Cleanliness of the animal itself is of the greatest importance. Grooming consists in the removal of dirt, dust, loose hair, and the dead portions of the epidermis; and besides, the friction necessary to accomplish the desired result stimulates the action of the skin. As the coat becomes loosened through the use of the brush, it affords a greater protection against cold and wet

weather. The use of the brush for grooming is to be recommended, while the use of the curry comb should generally be restricted to the cleaning of the brush. Washing horses is not commonly necessary, and should be avoided as far as possible, as it has a tendency to soften the skin, and sometimes gives rise to diseased conditions of it. There is also danger from the chilling which will result from washing. Grooming is usually confined entirely to horses, but other animals are benefited by the same measures of cleanliness. It is impossible to brush and clean large herds of beef animals, but dairy cows may and should be cleaned regularly. Not only will cows be more thrifty when properly groomed, but the milk from them will in consequence be much cleaner and more wholesome.

Blanketing and Bedding Live Stock. Under ordinary circumstances, farm animals are not in need of clothing, but in some cases it is well to provide horses with blankets. When a horse is tied out in the cold after severe muscular exertion, it is well to provide it with a heavy blanket. Animals kept in stables should always be provided with an abundance of good bedding, the soiled portion of which should be removed at least once a day. Good bedding adds to the comfort of the animals, absorbs moisture, and prevents the blemishes produced by animals resting on hard or uneven floors.

Care of the Feet. In horses, the care of the feet is of the utmost importance. Road and work horses should be regularly shod, and when this is unneces-

sary, owing to local conditions, the feet should be examined frequently, and all foreign bodies removed. This is best done when the animal is being groomed. In shoeing a horse, make the shoe fit the hoof. Many farriers practically fit the foot to the shoe, a process which usually requires so great an amount of trimming as to weaken the foot and give rise to lameness and malformations. The trimming should be confined to the bearing edge of the wall and to the dead horn. Under no circumstances should the frog and bars be pared. Rasping the outside of the wall is a bad practice, as it weakens it and makes it liable to become dry and brittle. The bearing surface of the shoe should be level, and in contact at every point with the corresponding surface of the wall.

Fit the Work to the Animal. In working a horse, see that it is fit for the labor which it is expected to perform. The use of a light harness or saddle horse for heavy draft purposes is usually as unprofitable as breeding Jersey cattle for beef purposes. We must select animals which are physically fit for the service which they are to render. Next in importance is the amount of labor to be performed by animals. Overwork tells on a horse the same as it does on a man, and the many forms of unsoundness so commonly seen in the limbs of horses bear mute testimony of this fact. While too great an amount of work or too heavy labor is always apt to injure an animal, the danger is most potent when it pertains to young horses which are being worked before

they have reached their full development. Before that time, the skeleton is more or less plastic, and too heavy a strain is apt to result in bone and joint diseases, such as splints, ringbones, and spavins.

Fit the Food to the Work. In caring for work horses the amount of food should correspond to the amount of labor performed. An animal will not be able to do hard work with an inadequate food supply, while one at rest will, if given an oversupply of food, be exposed to harmful consequences.

Exercise. The idle horse should have a certain amount of exercise to maintain good health. The above statement pertains to all farm animals, and is of special importance in the case of dairy cows and swine. It is usually sufficient to give the animals an opportunity to move about in a roomy lot or pasture.

Kind Treatment. In handling farm animals always bear in mind that they are entitled to kind and humane treatment, and that such treatment is always profitable to their owners. Animals should be accustomed to being handled, and to coming in contact with human beings at as early an age as possible. Young animals will soon become used to man, and, when they are once convinced that no harm is intended, a great advantage is gained, as beasts so treated tend to be gentle, and give us little trouble in handling them when they are older.

CHAPTER XXII.

DAIRYING.

Care of the Cow. The dairy cow should be well fed, and have access to water and salt at all times. Ventilate the stable as much as possible without making it too cold. Keep both the cow and her stable clean. The udder should be perfectly clean before milking. Milk regularly, rapidly, and thoroughly, and avoid a frequent change of milkers.

Milk Yield. A good cow should milk at least ten months in the year, and during that time she should give from five to eight thousand pounds of average milk. An inferior cow is very poor property, and should be disposed of as soon as convenient.

Composition of Milk. One hundred pounds of average milk contains about eighty-seven and a half pounds of water, three and a half pounds of fat, the remainder being other solids, such as casein, ash, and sugar. The fat in milk varies from two to eight per cent. Cow's milk is considered very rich when it gives a test of five per cent. fat.

Care of Milking Utensils. The pail, strainer, and other milking utensils should always be kept perfectly clean. In order to keep them clean it is necessary, not only to wash them carefully, but to scald them with boiling water. The boiling water

kills germs that would otherwise increase in great numbers and sour the milk.

Care of Milk. Strain the milk through a fine strainer immediately after milking. When fresh milk from the cow is left without special cooling, it sours very rapidly. The souring is caused by the action of bacteria which change the milk sugar to lactic acid. These bacteria multiply rapidly in warm milk. If the milk is cooled to a low temperature immediately after milking, it can be kept sweet for a long time.

Pasteurization. In order to prevent rapid souring and to kill disease germs, milk is heated to a temperature that destroys most of the bacteria, and then cooled to a low temperature. This process is known as pasteurization. If kept at a temperature of about 155 degrees Fahrenheit for thirty minutes, most of the germs will be killed, the milk will not be given a cooked taste, and, if immediately cooled down almost to the freezing point, it will keep for a long time without souring. Milk may be pasteurized in less time by bringing it to a higher temperature, but care must be taken not to cook it.

The Babcock Test. The Babcock test is a very simple method by which the per cent. of fat in milk can be determined. It is now the common way of determining the value of milk brought to our creameries.

Sampling the Milk. In order to get a fair sample from which to make a Babcock test, it is necessary that the whole quantity from which the sample is

to be taken should be thoroughly mixed. If the milk has stood for some time, pour it back and forth from one vessel to another, until it is thoroughly mixed.

Quality of Milk Used in the Test. In making the test for fat the quantity of milk used is seventeen and six-tenths (17.6) cubic centimeters. This is usually taken with a pipette, from which it is easily poured into the Babcock milk bottles. Two samples should be taken, so that the test may be made in duplicate.

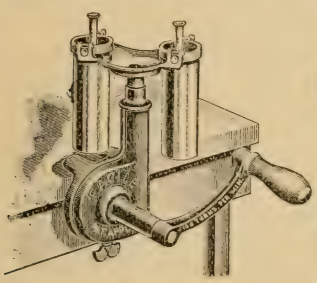
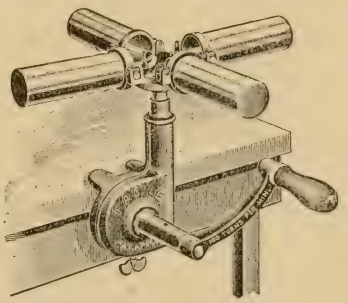


Fig. 57. Two-Bottle Babcock Milk Tester.



Four-Bottle Babcock Milk Tester.

Quantity of Acid Used. In making a Babcock test, commercial sulphuric acid is used. Seventeen and five-tenths (17.5) cubic centimeters of this acid are carefully poured into the bottle containing the milk to be tested. The acid should be poured down the side of the bottle, so as not to mix with the milk while being poured in. The acid, being much heavier than the milk, collects at the bottom of the bottle. After pouring in the acid, the bottle should be carefully shaken until the acid and milk are thor-

oughly mixed. The product should be of a brown color, which soon turns to black.

Use of Acid. The sulphuric acid acts chemically on all the solids of the milk except the fat. This sets the fat free, and facilitates its separation. If too much acid, or acid that is too strong, is used, or if the temperature is too high, the fat is burned. If too little acid, or if weak acid, is used, or if the temperature is too low, the casein will not all be held in solution, and the test will not be satisfactory. In order to get a satisfactory test, the milk should have a temperature of about 65 degrees Fahrenheit.

Whirling the Bottles. The bottles are now placed in the cups of the testing machine, and whirled at the rate of about nine hundred revolutions per minute for five minutes. In whirling, the acid and heavier parts of the milk are thrown to the outside,—that is, to the bottom of the bottle,—while the fat, which is the lightest part of the milk, comes to the top of the bottle. Hot water is now added until the bottle is filled to the neck, when it is again whirled for one minute. Enough hot water is then added to bring the liquid into the neck of the bottle so that the fat may all collect in the graduated part of it. The bottles are now whirled for one minute, immediately removed from the tester, and the percentage of fat read.

Reading the Per Cent. of Fat. The necks of the Babcock bottles are graduated, so that the reading gives the per cent. of fat in the milk. In reading the per cent., read from the lower edge of the lower

meniscus to the upper edge of the upper meniscus. The quantity of butter derived from milk is usually about twelve per cent. greater than the quantity of butter fat.

The Babcock Test on the Farm. Not only should the quantity of milk that each cow gives be known, but the milk of each cow should be tested frequently. What it costs to keep each cow should also be known. No dairy cow should be kept unless she is making a profit for the owner. A satisfactory two-bottle tester can be bought for about four dollars.

The Cream Separator. At our creameries and upon many farms, cream is separated from the milk by means of the cream separator. The principle upon which the cream separator works is very simple. The milk is whirled rapidly in the machine, and the heavier parts, which include water and solids not fat, are thrown to the outside by means of the whirling motion. The cream, being lighter, collects at the center, from which it is carried by means of a spout into the cream vat. Cream may be separated in this way from fresh milk. Such cream will be sweet. The cream separator also removes cream from the milk much more completely than is done by setting the milk in

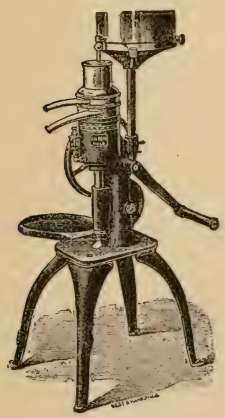


Fig. 58. Modern Type of Hand Separator.

pans, and letting it stand twenty-four hours before skimming.

Creameries. Prior to 1864, all butter was made on the farm. Since that time the system of associated dairying has rapidly advanced, and today there are in the United States more than ten thousand creameries in operation. If a sufficient amount of milk or cream can be obtained daily in a given locality, butter can be manufactured more cheaply in the creamery than on the farm. It is also possible to obtain a better price for creamery butter, because of its more uniform quality. Buttermaking requires skill, as well as the application of scientific principles. On the farm the amount of butter manufactured is too small to warrant the employment of some one skilled in buttermaking, consequently it is generally more profitable to patronize a creamery where it is possible to do so. Notwithstanding the rapid increase in the number of creameries, about two-thirds of the butter produced in the United States is made in the farm dairies. In North Dakota, a creamery, to be successful, should manufacture not less than sixty thousand pounds of butter a year. This will require the milk product of about four hundred cows. Co-operative creameries which farmers have organized, built, and equipped have been very successful and profitable.

Cheese Factories. The associated system of dairying was first taken up in the manufacture of cheese. Nearly four thousand cheese factories are operated in the United States, more than one-half of which

are in Wisconsin and New York. To produce cheese of a high and uniform quality requires considerable skill and attention. On the farm it is next to impossible to make a uniformly high grade of cheese owing to the small amount made. The factory product is more uniform, brings a better price, and finds a market more readily than farm cheese. The Northwestern farmer does not take kindly to cheese factories an account of the poor feeding value of the by-product (whey), and usually they are operated only during the summer months. North Dakota is better adapted to buttermaking than to cheese production. In 1900, only five and five-tenths per cent. of the cheese produced in the United States was made on the farms.

Butter. Butter is obtained by collecting the fat globules of the milk through some method of agitation. It is made up of a number of different fats, some of which have a very characteristic flavor. Average butter contains eighty-five per cent. pure fat, one per cent. casein, three per cent. salt, and eleven per cent. water. The quality of butter produced depends largely on the manner in which the milk and cream has been handled, the skill of the buttermaker, and the food eaten by the cows.

Oleomargarine. A product manufactured from oleo oil has been on the market for a number of years under the name of oleomargarine. Butterine is sometimes used as a commercial name for this product, especially when it is mixed with butter. When colored it is impossible to tell this product from but-

ter. Stringent laws have been passed regulating its manufacture and sale. When sold on its merits, the dairymen of the country have nothing to fear from oleomargarine. When properly made from wholesome ingredients, it is in no wise deleterious to health. The only objection to oleomargarine from the dairymen has been that it was colored to resemble butter, and generally sold for butter.

CHAPTER XXIII.

POULTRY.

Poultry Raising. It is not advisable to go into the poultry business on a large scale until one has learned it well, but every farmer should keep some poultry. One who finds it profitable should extend the business. Poultry raising requires little capital, a limited amount of land, and gives quick returns from the money invested.

Classification. On the basis of utility, the domestic hen may be classified as follows: Egg breeds, meat breeds, general purpose breeds, and fancy breeds.

(1) Egg Breeds. The egg breeds include those breeds that have a strong tendency toward egg production. They are smaller than the meat and general purpose breeds, but they are better layers. The Leghorns, Spanish, Minorcas, and Hamburgs belong to this class.

(2) Meat Breeds. The meat breeds are larger than either the egg or general purpose breeds, but as a rule they are not good layers. The Brahmas, Cochins, and Langshans represent the meat breeds.

(3) General Purpose Breeds. The general purpose breeds include those which are valuable both

for meat and egg production. Plymouth Rocks and Wyandottes belong to this class.

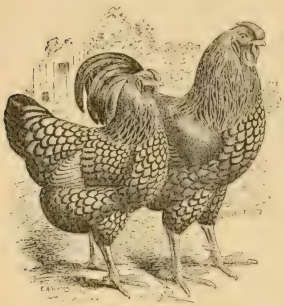


Fig. 59.
A Pair of Golden Wyandottes.

Fig. 60.
White Leghorn Cockerel.

(4) Fancy Breeds. The fancy breeds include those which have a peculiar or pleasing appearance, and are not bred for utility alone. The Polish and Bantams are representatives of this class.

Leghorns. The history of this breed is obscure, but it is one of the Mediterranean breeds, and is supposed to have been brought to America from the city of Leghorn, in Italy. Leghorns are rather small, but rank high as egg producers. They begin laying when quite young,—sometimes at the age of five months,—and, if well cared for, lay well during both the summer and winter. Large flocks have sometimes produced two hundred eggs per hen in a single year. The Leghorn varies much in color, as is indicated by the names of the varieties of the breed. These are: White, Rose Comb White, Black, Brown, Rose Comb Brown, Buff, and Silver Duckwing.

Brahmas. The origin of this breed is not positively known. Some assert that it originated in Asia, others that it is an American breed. The Brahmas are a very popular breed. They are probably the largest breed in existence, and rank high as meat producers.

Plymouth Rocks. The Plymouth Rocks probably originated in Massachusetts about the middle of the nineteenth century. They are very popular as a

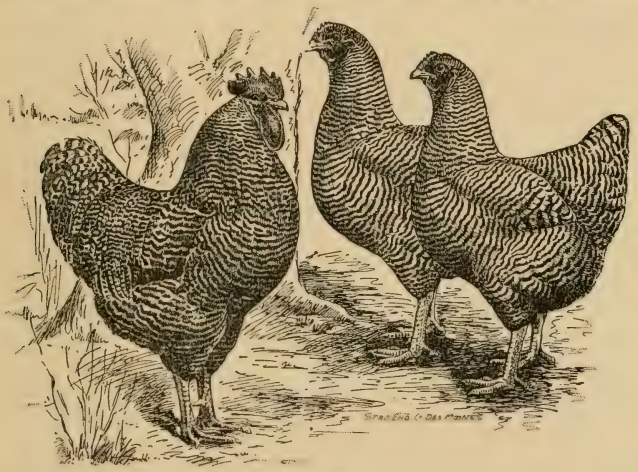


Fig. 61. Barred Plymouth Rocks.

general purpose breed. In size they are not far behind the meat breeds, and in egg production they approach the egg breeds. There are three varieties of Plymouth Rocks,—the Barred, Buff, and White.

Bantams. The Bantam is purely a fancy or ornamental breed. They cannot successfully compete with either the egg or meat producers.

Care and Management of Poultry. The average farmer pays but little attention to his flock of hens. No attempt is made to follow a regular system of feeding, and poultry raising is often considered unprofitable. The keeping of poultry requires constant supervision, and somewhat closer attention to details than the production of other classes of live stock. If one has a good knowledge of the business, it offers as great an inducement for the money invested as any line of work in animal husbandry. The essential factors to keep in mind, when one is raising fowls either for egg or meat production are location, housing, cleanliness, and feed.

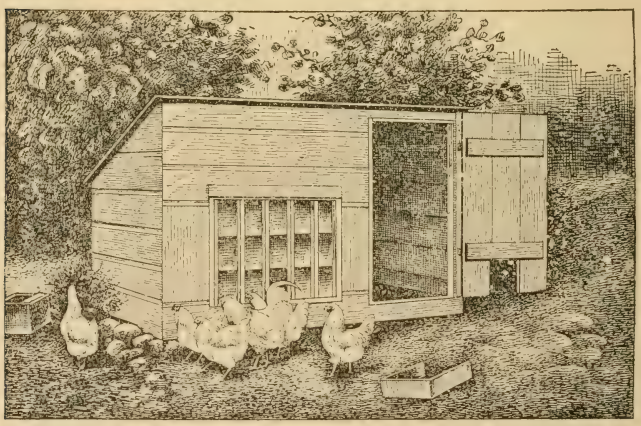


Fig. 62. Chicken House. Cheap, light and easily built.

(1) Location. A healthful location for the poultry house should be the first consideration when building. Select or prepare a dry, somewhat ele-

vated surface, so that the free water will drain away in all directions. A porous loam, or gravelly soil makes the best possible situation, as no unnecessary moisture will then remain around the buildings, thus insuring comparative immunity from disease,—an essential factor in successful poultry raising. If the house is placed about a foot above the ground, leaving a free space underneath, it will help protect from

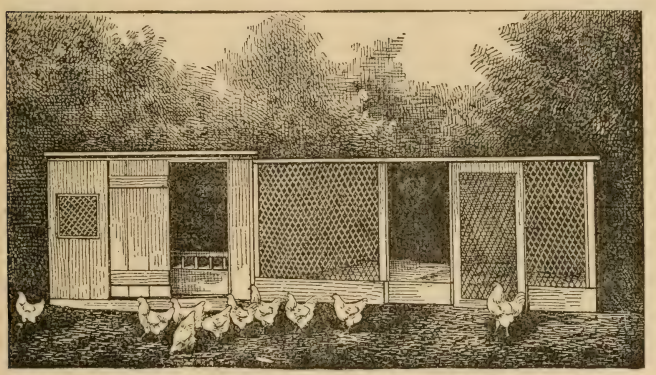


Fig. 63. Chicken House With Scratching Shed Attached.

rats, which are deadly enemies of young chicks. A location where fowls can have access to sunshine during the cold months is very desirable. Plenty of sunshine stimulates egg production by maintaining a high standard of vigor in the flock. To this end, a southern exposure, both for the yards and houses, is desirable. During the summer months it is necessary to supply shade for fowls either by artificial structures or by means of trees or shrubs planted where the fowls can have access to them.

(2) Cleanliness. A fair degree of cleanliness is absolutely essential to successful poultry raising. The runs or yards should never be allowed to become foul. This can readily be prevented by spading or plowing them at least once a year. If the whole interior of the poultry house is given a thorough whitewashing in the spring and again in the fall, before the cold weather sets in, it will materially assist in keeping down the vermin. The whitewash can be applied easily and quickly with a spray pump. Frequent applications of some reliable lice killer or a kerosene solution to the roosts will be found necessary, as the cracks in them serve as hiding places for the red mites during the day.

(3) Warmth. As the cold season approaches, fowls quit laying unless warm quarters have been provided for them, as all their food is required to maintain warmth in the body when they are confined in cold quarters. A model poultry house should be so constructed that artificial heat will not be necessary; but if this must be resorted to, care should be taken to maintain an equable temperature. A temperature of about 40 degrees Fahrenheit proves very satisfactory.

(4) Importance of Good Feed. Poultry on the average farm are given their full liberty. The owner expects them to gather food, during the warm weather at least. If he gets poor results from his hens in the way of limited egg production, the fowls are blamed, while in reality the fault lies with the owner. The old saying that "you cannot get some-

thing from nothing'' applies well in this case. Naturally a hen will first retain in her body all the food necessary for the maintenance of life, and all foods in excess of this will be manufactured into eggs or flesh by good fowls. Only by careful and judicious feeding, and by adopting a regular and reasonable system of management, can the poultry raiser hope to attain the best results.

CHAPTER XXIV.

BIRDS.

Birds are among the most faithful helpers that the farmer has. They are diligent in their work, and their board is the only pay exacted. Did you ever ask yourself why the King Bird and Swallow make such sudden darts here and there as if in search of something? They are seeking their food, which consists mostly of insects. A large proportion of these insects injure economic plants, consequently, the greater the number of injurious insects destroyed by birds, the larger and better will be the crops. In some parts of the country, thoughtless people have killed many of our best birds, and, as a result, the insects have increased to such an extent that the products of the farm and orchard are much decreased in quality and yield.

Birds, like people, must be classed as good and bad. Some birds have few bad traits, some have good and bad habits, while a few birds, such as the English Sparrow, have scarcely a redeeming feature. It is reasonably safe to assume that a bird is a friend to the farmer, at least until the case is clearly proven against him. Our singing birds, almost without exception, are strong allies of the farmer. There

are many kinds of birds, but only a few of them can be mentioned here.

The Crow. This bird belongs to the second class mentioned above,—he has bad habits as well as good. He is fond of pulling up sprouting corn in the spring, and he also likes the ears of growing corn when they are in the milk stage of growth. He has been known to suck eggs, and he sometimes kills young chickens. Perhaps his worst habit is that of feeding upon the eggs and young of other birds. But with all these things against him, the crow does the farmer an immense amount of good by destroying insects and mice. The insects eaten consist largely of grasshoppers and May beetles, both of which cause much injury to the farmer. The crow is exceedingly fond of mice, which are a nuisance to the farmer, as they destroy grass roots, girdle young trees, and consume large quantities of grain.

Woodpeckers. Nearly all of the woodpeckers are valuable to man. When you hear a woodpecker beating a tattoo upon a tree, you may be sure he is seeking some injurious wood borer.

Hawks and Owls. Few people have much love for these birds. Because some hawks and owls are fond of poultry, all are condemned, shot upon sight, and given no quarter. This method is quite wrong, as several kinds are of great value to man, and do little, if any, harm. The principal food of many of the hawks and owls consists of mice, gophers, prairie dogs, and rabbits, all of which are injurious

to the farmer. If a hawk or owl is found catching chickens, it should be killed, but that does not warrant an indiscriminate destruction of all hawks and owls that can be found. To shoot these friends of the farmer is a poor kind of sport, and to shoot them in fancied self-defense is a piece of folly based upon ignorance.

English Sparrows. English sparrows have been given a vast amount of study, and nearly all investigators agree in considering them a great nuisance. They not only eat the crops and let the insects alone, but they attack, kill, and drive away valuable birds from their nesting places. They have been observed to molest over one hundred different kinds of birds, most of which belong to beneficial species.

Pleasing Qualities of Birds. Aside from the great money value which birds are to man, they afford him pleasure by their beauty, song, and tender attention to home duties. No one who has a kindly regard for the rights of birds, or who has a sympathetic interest in our feathered songsters, would so far forget himself as to use the birds for personal decoration. It is a custom inherited from the barbarians, and should be left to them.

CHAPTER XXV.

FRUIT CULTURE.

What to Produce. The fruits best suited for cultivation in North Dakota are the plum, strawberry, currant, gooseberry, and raspberry. The wild representatives of all these may be found here and there in many parts of the state. All of them have considerable value, and many of them can be cultivated to advantage in our gardens.

Origin of Cultivated Species. Generally speaking, the cultivated fruits of any region are developed in that region. Nearly all of the well-known fruits cultivated in the United States are but improved forms of the native species, and our valuable varieties of the introduced species, like the apple, originated in this country.

How Fruits Are Improved. Some of the wild fruits, like the native plum and gooseberry, improve rapidly under cultivation, if from the best individuals a systematic selection of seed is made. The Concord grape originated in the second generation from the wild grape of the woods; and many other instances are recorded of a marked improvement within a comparatively short period. The work of improving native fruits is interesting, and furnishes a means of study and entertainment that almost any

one can pursue with some degree of profit. The advantage of a student taking up some independent line of scientific work can hardly be overestimated. It develops a capacity for independent research that cannot rapidly be acquired in any other way.

CULTIVATED FRUITS.

Plums. Under our present conditions, the most valuable fruit for general cultivation is the plum. The improved varieties of the common wild plum are the only ones that will be found hardy and profitable. They like deep, moist soil, and require only such attention as will keep the trees thrifty. A northwest slope is best, though they will do well upon level land. Good, native soil requires no enriching for plum growing. Some protection on the south in the way of a good windbreak of willows and soft maple or other dense-growing trees is essential to continued success. The trees should be planted about ten by sixteen feet apart, and kept well cultivated, especially for the first few years. They should be mulched with straw each fall until they are three or four years old; and where the ground is pretty sure to be bare of snow, one should never give up mulching the trees for winter, to prevent root killing when the weather is very severe. They need practically no pruning, but the suckers must be kept down if they appear. The Wyant, Surprise, and De Soto are among the best varieties. They should begin bearing when three or four years old. Have a few trees of the best wild plums of the

neighborhood growing among the others. Each fall plant a number of plum pits, saved from the best trees as they come into bearing.

Currants and Gooseberries. These plants do well in a moist, cool, heavy soil, and, like many other fruits, do better on a north or northeast slope. Set the plants, as they are obtained from the nursery, about four by eight feet apart. The secret of success with these fruits is to keep the bushes small and compact, allowing but eight or ten canes to each plant, cutting out all canes four years old, and allowing but two or three new ones to grow each season. Like other fruits, they should be given clean cultivation. While not absolutely necessary, it is a good plan to mulch with straw early each fall. The soil should be enriched from time to time by cultivating a liberal dressing of stable manure into it. Keep out all grass and weeds.

Strawberries. With a good windbreak on the south and west, and a deep, moist soil, one can be practically sure of success with this fruit. Set the plants in early spring, two by four feet apart. Set them carefully, with the crown just at the surface of the ground, and the roots well spread out and extending directly downward. Pack the earth firmly about each plant, and, if the weather is dry, water them twice each week until the plants have started. Give thorough cultivation, and remove all of the runners from each plant except the first three or four that start. In the fall, after the ground has frozen, cover the bed with four inches of straw. In

the spring, after the plants have shown signs of starting, remove the straw, leaving it between the rows. The bed will need no further attention until fruiting time, except an occasional light hoeing between the plants to keep down the weeds. After the fruit is gathered, prepare the bed for the next season by cultivating thoroughly, and by removing part of the straw if necessary. This cultivation should be kept up until the close of the season, and most of the runners should be removed as they appear, leaving but three or four to each plant. After the second crop has been gathered, the bed should be plowed up, another having been started the previous spring. One must test his own varieties to a certain extent, taking care to have half of the varieties of the staminate sorts to insure fertilization. The Senator Dunlop, Warfield, and William Belt are the most valuable varieties for us at the present time.

CHAPTER XXVI.

PROTECTION AND ORNAMENTATION OF HOME AND SCHOOL GROUNDS.

Purposes. Trees and shrubs should be planted about the home, first, for protection and comfort, and, second, for ornamentation. We have the same reasons for planting them about the school grounds, with the added one that they furnish means and material for education. Tree planting for ornamental effect is one of the most important elements in landscape gardening. This is one of the fine arts, closely related to painting, and governed by the same laws. The difference lies in the fact that, instead of using the brush, the landscape gardener makes his pictures by the use of natural objects. Landscape gardening, like other arts, cannot be taught wholly by rules. One must practice the art in order to excel in it. Still there are certain principles to be learned before one can even plant a dooryard so as to get the best effect.

Principles. The principles involved are not fixed and arbitrary, like those of the exact sciences. For convenience they may be stated something as follows: First, make a picture with a foreground and background. The buildings will naturally be the key or central object. All elements in the picture should

express the same idea, giving unity. Second, make the picture natural by arranging the trees, shrubs, and flowers as nature would have done, in masses, groups, and borders. Third, give the picture variety and interest by using a number of different kinds of trees and other plants, arrayed in a pleasing and effective manner. Fourth, select plants well adapted to the region, and grow them properly, so they will be thrifty, and thus avoid the expression of poverty. Fifth, keep the trees trimmed if they are inclined to grow straggling. Destroy all weeds or other unsightly features, so the place will look refined and polished, and not straggling and neglected.

Plan. In making an application of these principles, the first step is to plan the picture. Nature has sometimes helped in this by furnishing a sightly hill for a background, or a mass of trees that can be used in like manner. It is more often the case that one has but the bare canvas to begin with. In either case, draw a plan of the grounds to some convenient scale, say eight feet to an inch, locating the boundaries, buildings, and other fixed features. Next decide upon the location of the walks and drives, and for the home grounds locate the gardens, clothes drying yard, etc., making the arrangements as convenient as possible. Have the walks few and direct, avoiding tortuous, "snaky" curves. Strong natural curves in a walk or grove may be an advantage, and look better than straight lines. Have the walks made with even, clean-cut margins. Provide drainage and surface with good gravel or cin-

Fig 64. Peter Severt's Grounds in Canby, Minn., in 1886.

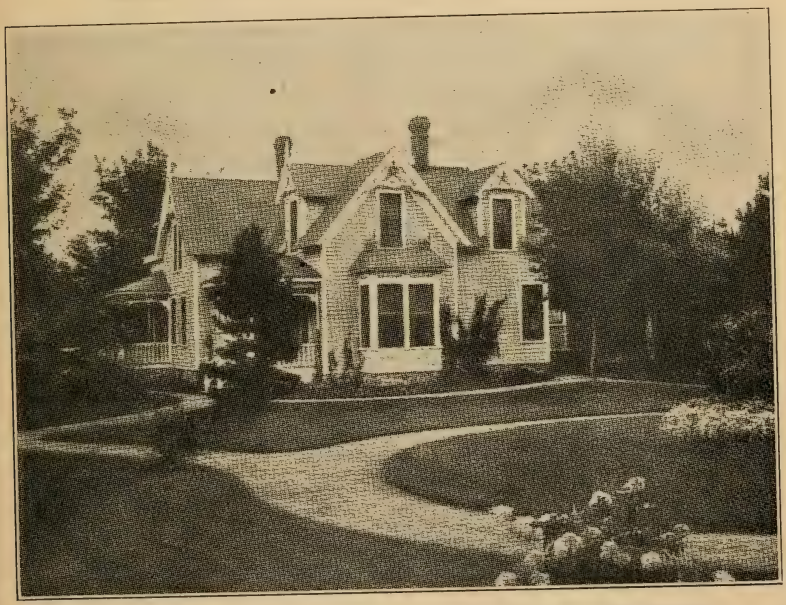


Fig. 65. Peter Severt's Grounds in Canby, Minn., in 1903. Showing result of planting trees and shrubs.

ders. Hard brick or cement walks are not very expensive, and are better than dirt walks, especially near the buildings.

The Lawn. The lawn is perhaps the most important element in the adornment of home grounds, and hardly less so with school grounds. No system of planting can make a place really attractive when the intervening spaces are bare and patchy, while, on the other hand, a perfectly plain plat of grass, if it be rich and green, is attractive. Therefore, in drawing the plan, provide a central open expanse that will be an unbroken lawn. Cut it by walks only where necessary, and plant trees and shrubs upon it, not so much for their own attractiveness as for the interest and spirit they add to the picture. It is possible for the finest trees to spoil a good view, and they should be so placed as to avoid this possibility.

Location of Trees. The planting of trees will then be chiefly at the rear and sides of the place, where they will afford a proper setting and background for the buildings and other objects. They lend not only the artistic effect required in the way of form and color, but they add to the picture the expression of dignity and permanence always characteristic of trees. This expression lends to gardens one of their greatest charms. We cannot admire things crude and uncouth, least of all a landscape that is crude and uncouth. In the arrangement of the trees, much can be done to avoid the expression of newness and crudeness. To do this, plant the trees in such a

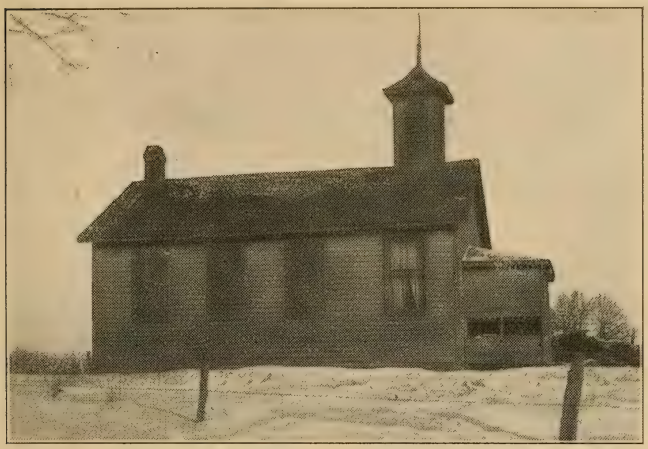


Fig. 66. A Type of Rural School Building and Grounds in Washington Co., Minn., Which is Rapidly Disappearing. Photo taken in 1904.

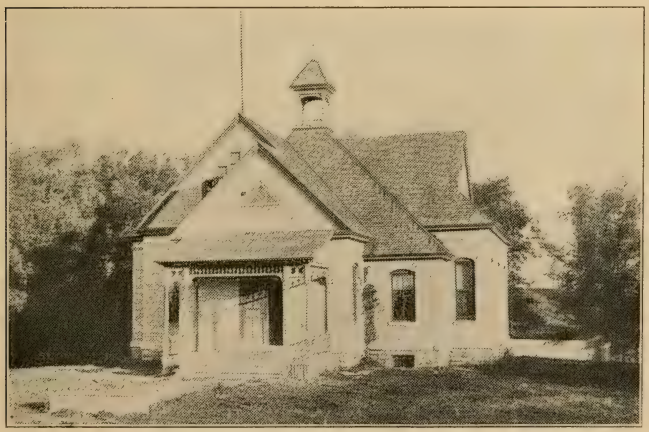


Fig. 67. A Model Rural School Building and Grounds in Hennepin Co., Minn. Photo taken in 1904.

manner that they will appear to have sprung up there naturally. Plant in groups and masses, arranging the different varieties so as to have the larger ones at the center and back, and the compact, smaller ones in front. After three or four years, no one will think that the trees are not of nature's planting. The landscape expresses ease, quietness, and repose,—elements to be greatly sought after. For this kind of planting, cultivate every portion of the grounds to be planted, and set the trees thickly, four or five feet apart for the small trees, and thin them out as they crowd each other. Have the inner line of the border in which the trees are planted more or less irregular, but not so much so that the plantation will appear straggling.

Varieties of Trees. For the main planting, use shade-giving trees, like the ash, soft maple, Norway maple, box elder, elm, hackberry, linden, and white birch. Along the borders, plant the native shrubs, and such hardy foreign ones as the lilacs, snowball, purple barberry, bush honeysuckle, etc. Don't scatter them too much, but plant the different sorts more or less by themselves in masses blending into each other.

Groups of Trees. If the expanse of lawn is considerable, one or more groups of trees or shrubs may be so placed that they will add to the effect. Make them large enough to command respect, and observe the same rules as given for planting the borders. Also plant masses of shrubs against the build-

ing, making free use of vines like the wild grape and woodbine.

Planting Flowers. Flowers always add interest and charm to a place if properly planted. Placed among the shrubs and along the borders, they may be made very effective with little care. For many reasons it is hardly worth while to try to grow them in beds upon the open lawn. There are very many hardy perennials, both wild and introduced, that make themselves quite at home along the borders, protected by the shrubs, and require very little care after the first planting. The peonies, hardy phlox, iris, hardy lilies, yucca, ferns, violets, and countless others may be placed here from time to time, where they are sure of finding a congenial home.

CHAPTER XXVII.

CARE OF FARM MACHINERY.

Farm Machinery Necessary. Modern methods of farming, and the wages paid to hired help, make necessary the extensive use of farm machinery. Some of this machinery is very expensive, and, if not well cared for, must frequently be replaced.

Keep Bearings Oiled. Good machine oil is comparatively cheap, and is easily applied to the bearings of the various kinds of farm machinery. The rapid running parts of such machines as mowers and binders should frequently be oiled in order to prevent heating.

Keep Bolts Tight. It is truly said that "a stitch in time saves nine," and, in the case of our modern farm machinery, the tightening of a nut, or the replacing of a broken or badly worn bolt, not only saves time, but frequently many dollars that must otherwise be spent for repairs. A man who is alert and interested in his work will usually notice as soon as anything goes wrong with the machinery he is handling, and will remedy it at once.

Replace Wornout Parts. If any part of a machine is found to be badly worn at the close of a season's work, it may be wise to replace it before using the machine the following season. This often makes

it possible to avoid long delays caused by the necessity of making repairs during the busy season. Thoroughly repairing farm machinery during the periods when farm work is slack usually proves a good investment.

Polished Surfaces of Plows and Cultivators. The bright steel surfaces of plows and cultivators should always be kept clean and free from rust. If this is not done, much time will be lost in getting them burnished so that they will scour in the soil. Oil applied to the polished surfaces when the machine is not to be used for some time will protect the parts which are otherwise liable to rust. When not in use, it is well to remove and store cultivator shovels and other polished parts in a dry place.

Machine Sheds. Few investments pay better than a good machine shed. It has often been demonstrated that farm machinery which is housed during that portion of the year when not in use lasts several times as long as machinery that is exposed to the sun, dew, and rain throughout the year. Such a shed need cost only a fractional part of the value of the machinery that it will protect.

CHAPTER XXVIII.

ROADS.

Location of Roads. Where it is possible, each section line should be converted into a highway. From thirty-three to sixty-eight feet are required for a legal roadway, of which the land-owner on each side must give half.

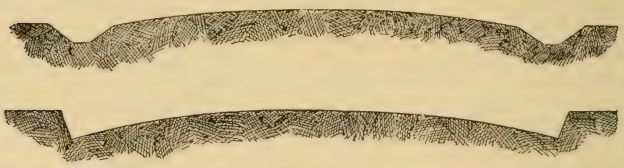


Fig. 68. Properly Crowned Earth Road. Cross sections of two good forms for earth roads. The lower section can be made with a road machine, and both sections can be rolled and constructed so that water will run off easily and quickly.

Building Dirt Roads. The side ditches and middle ridge are rapidly formed by the use of a road machine, consisting of a heavy plow and revolving rubber canvas. The plow part of the machine cuts

Fig. 69. Poorly Crowned Earth Road. Cross section of a 14-foot road showing the result of improper construction and drainage. Note that the center of the road has become the lowest part and that water may collect on the surface, making the road practically impassable.

the ditch, while the canvas delivers the dirt several feet away, and near the middle of the road. This

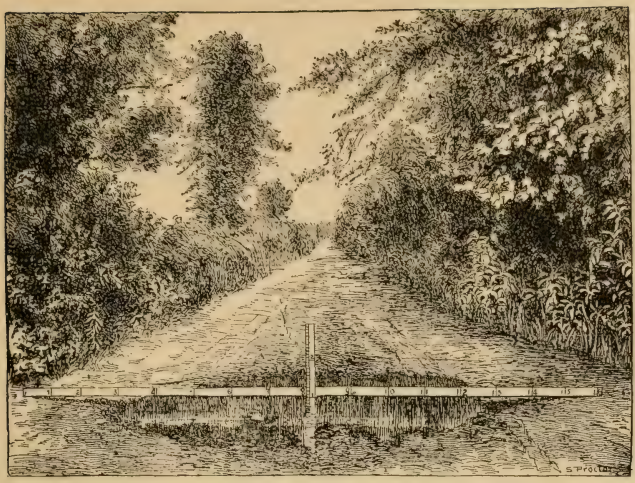


Fig. 70. Poorly Crowned and Badly Drained Roadbed.

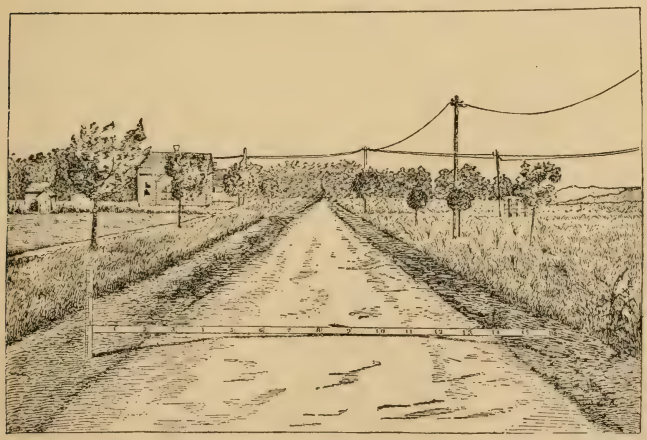


Fig. 71. Properly Crowned and Well-Drained Earth Road. Note slope from center to sides. Road was worked with road machine and horse roller in March. Photograph taken June 1, about forty-eight hours after long, hard rain.

Note: Above cuts reproduced from Farmers' Bulletin No. 136, U. S. Dept. of Agriculture.

grading machine leaves the road bed rough, lumpy, and uneven, and it should be followed by a disc harrow or pulverizer, which will cut the lumps into fine, workable pieces. After the clods are reduced, a reversible road grader in the hands of an expert will form the bed into any shape desired.

Avoid Steep Grades. The load which can be carried is measured by the steepest hill, and one short grade of a few hundred yards may reduce the load which can be hauled for ten miles one-fourth in weight. Where a rise of more than seven feet in one hundred occurs, it should be cut down by the use of the wheeled or slush grader. Cutting at the crest of the hill, and depositing the dirt at the foot of the slope, will reduce the grade, and, while it is a slow process, compared with the work that can be done with large grading machines, it is the best-known method for carrying dirt from one point in the roadbed to another some distance away.

Road Drainage. A form of construction which will avoid standing water is the chief secret in maintaining a good road. Furrows or ditches along each side of the roadbed furnish dirt to build a rounded surface for vehicles to pass over, and, in addition, serve to carry the water away to the natural ravines and rivers which form the final outlets for all the extra surface water that falls.

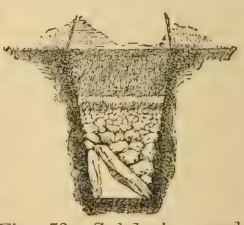


Fig. 72. Subdrain made with field stones.

Tile Drains. Tile drains beneath the surface of

the ditches will rapidly absorb and carry away the water which does not find an outlet within a few hours after it falls. They have the advantage of allowing the use of shallow road ditches, and of assuring more certain and thorough drainage. Laying tile in the manner described is rather expensive, and is practiced only in older and more wealthy communities.

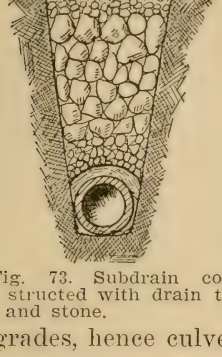


Fig. 73. Subdrain constructed with drain tile and stone.

Culverts. Natural waterways must not be dammed by road grades, hence culverts and bridges must be supplied to avoid obstructing them. Tile drains form one of the most efficient and durable forms of culverts. Where waterways are too wide to admit of the use of tile drains, wooden structures are usually provided. If stone arches can be built, they form a permanent and therefore economical construction for the passage of streams; although the first cost is usually too great to permit of their adoption.

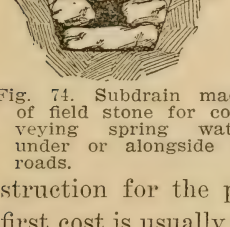


Fig. 74. Subdrain made of field stone for conveying spring water under or alongside of roads.

Weedy Roadsides. Weeds should not be allowed to grow along the roadsides. They give the road a slovenly and neglected appearance; they prevent quick and complete drainage of the surface, and they cause snow to lodge and form drifts during the winter season. The occasional use of the harrow will

not only prevent the growth of weeds, but it will fill the wheel ruts, level the surface, and greatly improve the roadbed by insuring rapid drainage from its surface. A sloping ditch bank next to the field will allow it to be plowed and farmed to the bottom of the furrow. This will prevent the growth of weeds along the roadside next to the field. Where time cannot be spared to destroy the weeds by the use of the harrow when they are small, a mower can be run over them once or twice during the season to advantage.

Special Forms of Roadways. Expensive special forms of roadbeds are usually made only ten to sixteen feet wide. This reduces the cost of construction, and gives drivers an opportunity to use the dirt bed on either side during the times when it forms a better roadway than the specially constructed ones. There are a great many special forms for building roadways and pavements, only three of which will be taken up in this volume, viz., surfacing with gravel, sand, or clay, the Macadam system, and the Telford roadbed.

(1) Surfacing with Sand, Gravel, or Clay. Surfacing roadbeds is practical in only a few places. Where stretches of heavy, sticky clay roads are found close to sand pits, they can be greatly improved by hauling sand and depositing it upon them in such quantity that it will become mixed with the clay and form a hard crust over the surface. Such a road will not readily form ruts, nor become sticky enough to clog wheels. Roadbeds which consist of loose sand will be greatly improved by having clay

Fig. 75. Type of Road in Massachusetts Before Improvement.

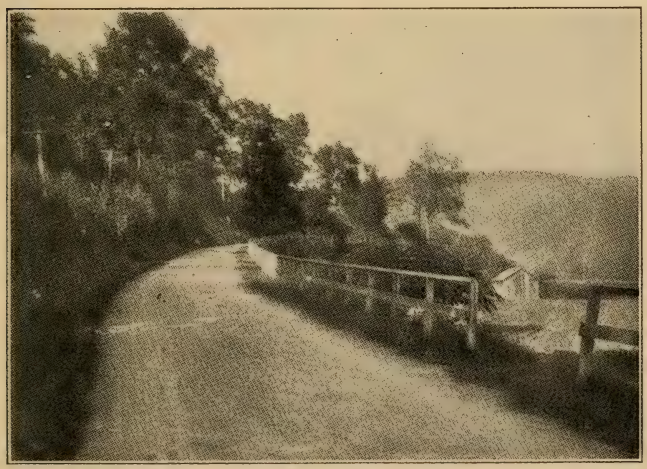


Fig. 76. Type of Road in Massachusetts After Improvement.

thrown upon them, the effect of which is similar to that already described for clay roads. Clayey or heavy loam roadbeds may be improved by covering their surfaces with a shallow layer of gravel.

(2) The Macadam Roadbed. Many years ago a man named Macadam introduced a system of artificial road construction which has been adopted by many cities, towns, villages, and rural communities, and it has given good satisfaction in almost every instance. It is used only where medium loads are hauled; and some regular form of pavement should be provided for the heavier dray work which must occur in cities, even during bad weather. A roadbed for a Macadam road is constructed the same as though it were to remain a dirt bed, except that a hollow is left in the middle for depositing the small, angular pieces of stone which form the roadbed. Granite or other hard stone is broken into fragments and packed firmly by running a heavy iron roller over it. The road is watched closely, and additional stone is added to fill the ruts which the wheels of vehicles are sure to make in it when the roadbed is new.

(3) The Telford System. The Telford road bears the name of the originator and differs from the Macadam in that the foundation consists of quite large stones, which are carefully laid in a well-formed bed. Next, a layer of fine stone, much like that used by Macadam, is placed over, until the foundation or stone bed is covered to a depth of seven inches. Over this, sufficient gravel is scattered to fill all of the smaller cavities, and bind the covering into a firm, resistant layer.

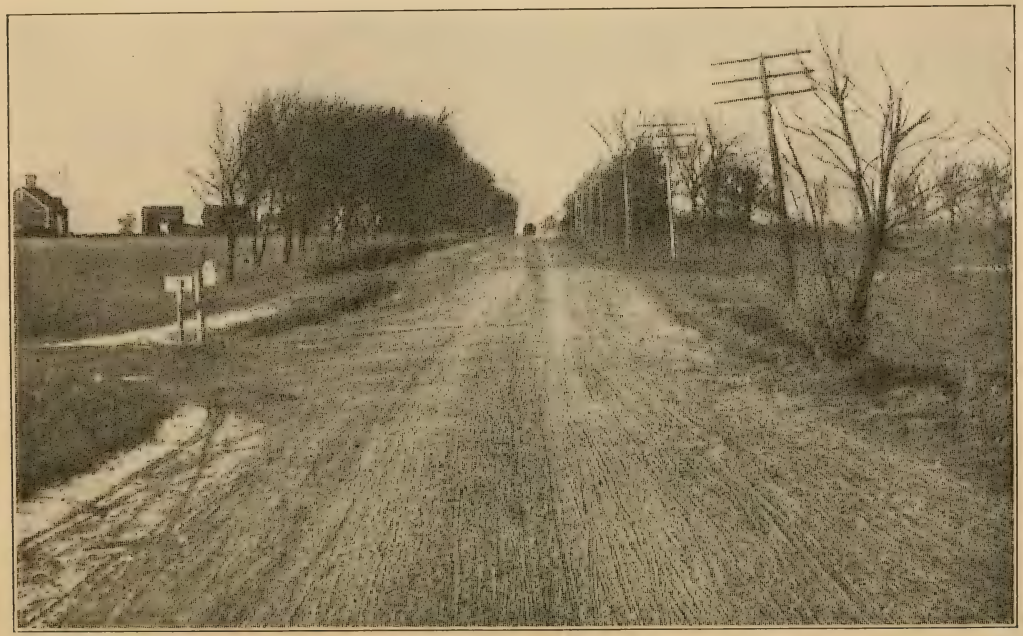


Fig. 77. Gravel Road, 3 Years Old, 4 Miles North of Minneapolis.

CHAPTER XXIX.

SOILS.

What is Soil? As commonly used, the term "soil" means that portion of the earth's crust into which plants send their roots for food and water. It is usually disintegrated rock, mixed with organic matter. That portion which is near the surface, and rich in humus, is termed "soil," and that beneath, "subsoil." Humus in soil makes it dark in color, consequently soil is generally much darker than subsoil. In dry regions, where crops can be grown only by irrigation, there is often no difference in the fertility of the soil and subsoil, and no line of demarkation in color appears. Even earth from depths of thirty feet or more may be as productive as the surface.

Origin of Soil. Soil has been formed mainly from rocks that have been broken or ground up by various natural agencies. The agents that have had most to do in soil formation are heat, water, gases, micro-organisms, and vegetable life. Usually these agents have combined to bring about the disintegration of rocks.

Heat. Heat causes most substances to expand, and cold causes them to contract. The expansion

and contraction is not uniform for different substances, consequently some portions of a rock expand or contract more rapidly than others, causing the particles to break apart, and the rock finally to crumble. This process is usually spoken of as the weathering of rocks. Weathering is also brought about by the freezing and thawing of water that the rocks have absorbed.

Water. Running water is the greatest agent in the transportation of soils. During every heavy rain a great amount of soil is transported, and some of it to quite a distance. Rivers and even small streams are instrumental in carrying vast quantities of soil from one place to another. In past ages, glaciers transported a large amount of soil, and they are still at work in some of the colder regions.

Micro-organisms. Micro-organisms, while very small, are often numerous, and have had much to do in working over inorganic rock into organic matter. They absorb material from the solid rock, and leave it in the form of fine soil.

Vegetable Life. Plants live principally on water, air, and partially decomposed organic matter, but, to some extent, they derive nourishment directly from rocks. For example, if a plant root grows along the surface of a piece of marble, it will take enough material from the marble to roughen the surface. In this way, rock is slowly but surely ground up into very fine particles of soil. After rock has been ground up quite fine by other agencies, small animals, such as earthworms, swallow it,

and further reduce it by the action of their digestive tracts.

The Entire Surface Covered by the Sea. Probably all parts of the earth's surface have at one time or another been covered by the waters of the sea. These waters have had much to do, not only in grinding the surface rocks, but in separating the sand, silt, and clay. The largest and heaviest particles are deposited first, and the finest and lightest last. When sediment is carried down by the rivers, the fine particles are carried far into the sea, while the coarser ones are dropped early. The waves of the sea, beating on the shores, carry away the clay and leave the sand. These instances of the action of water in separating soil elements show how the sandy sea shores are formed. Sand and clay are often found deposited in layers, called "strata." This stratification is the result of water action.

Why Valleys are Usually Rich. A portion of the water that falls to the earth in the form of rain or snow runs down the hillsides toward the valleys. Such water, if it runs slowly, gradually carries the clay and silt towards the valley, leaving the heavier sand behind, and even the rapid flowing stream carries the finest particles farthest. This is why the surface of the valleys are so often covered with a deep layer of clay and silt, and it also accounts for many hillsides being barren.

The Action of Glaciers. Thousands of years ago a great glacier came down from the northeast across North America. This glacier was a vast

sheet of ice hundreds of feet in depth, and it covered nearly all of North America east of the Rocky Mountains, and as far south as the Ohio and Missouri Rivers. In some places the glacier crossed what is now the location of these rivers; in other places it may not have extended so far south. This great body of ice carried large masses of earth and rock before it, breaking and grinding them to pieces. This great ice sheet retreated annually before the heat of summer, causing the earth that the glacier was carrying to be deposited. The glacier advanced the next winter, repeating the work of the year before. By constantly advancing and retreating, the glacier greatly modified the surface, and left a soil peculiar to the portion of the United States north of the rivers mentioned. Most of the soil of Minnesota, and a large portion of the soil of North and South Dakota, is of glacial origin.

How the Red River Valley was Formed. When the great glacier began to retreat to the north, in what is now the Red River Valley, it formed a dam which held back the water and made a great lake. Geologists have named this ancient body of water, Lake Agassiz. The rich prairie soils along the Red River are composed of sediment from the waters of this great lake. When the ice sheet retreated to the far north, Lake Agassiz was drained into Hudson Bay.

Glacial Soil West of the Valley. The soil between the Red River Valley and the Missouri River is of glacial origin, while in some places the glacial

soil extends quite a distance west of the Missouri. Glacial soil is quite variable in composition; some of it being a rich, clay loam, other portions a sandy loam, and still others quite sandy.

The Bad Lands. A portion of the region west of the Missouri River is known as the "Bad Lands." Scientists say that the Bad Lands are not burned out coal mines, as some suppose, but are simply the results of erosion. For many ages the Bad Lands region has been washed by rains, until it has become very rough. This washing has removed the richer particles of the soil, and has left it, in many places, quite barren.

Classification of Soils. Soils are classified in several ways. They may be classified as light and heavy, warm and cold, or as sand and clay soils, with many intervening grades.

Light and Heavy Soils. Light and heavy are practical terms applied to all soils. These terms do not apply to the weight per cubic foot, for the soils called light are the heaviest soils we have in weight. A heavy, clay soil, when dry, weighs from seventy to eighty pounds per cubic foot, while the lightest kind of sandy soil weighs from one hundred five to one hundred ten pounds to the cubic foot. It is the ease or difficulty with which these soils are worked or tilled which give rise to the terms "light" and "heavy." In light soils the roots of plants push their way easily, while in stiff soils they thread their way with more difficulty, and are usually not distributed so thoroughly. As a result, the roots

of plants in heavy soils trespass upon each other's feeding grounds, and do not get the benefit of the whole soil so completely as they do in the lighter soil. On the other hand, light soils are usually not so rich in plant food as heavy ones.

Warm and Cold Soils. Soils are also called warm and cold in reference to their temperature in early spring. The strongest factor in determining the temperature of soil is the amount of water it can hold and bring to the surface. Those holding the most water, and delivering it the most rapidly to the surface, are usually the coldest soils.

Sand and Clay. Soils are also classified, according to the size of their particles, into sandy soils and clay soils, with many grades between the two, resulting from a mixture. Soils that are made up mostly of coarse grains are called sandy soils, while those that are composed of very fine particles are called clay soils. In addition to the difference in the size of their particles, sandy and clay soils usually differ in their chemical composition.

Loamy Soils. Loamy soils have their grains intermediate or between those of the sandy and clay types. In loamy soil we have, on the coarser grained side, sandy loams and loamy sands, and, on the finer grained side, clayey loams and loamy clays, there being, of course, an insensible shading of one of these types of soil into another. In parts of the world where these different types occur, it is found that each produces plants peculiar to itself. Some plants have suited their roots to the coarser, drier soils

more economically than others can, while other plants and trees, in the long years of fitting and refitting, have come to thrive and grow best on heavy clay soils. Besides the soils described above, there are swamp, muck, peat, and humus soils, all of which contain a very high percentage of decaying organic matter or humus.

Chemical Composition of Soils. A soil that contains much plant food is said to have a rich chemical composition. When soils do not have a satisfactory chemical composition they usually lack nitrogen, phosphorus, or potassium. The roots of clover, alfalfa, peas, and beans have the power, by means of bacteria living in the nodules on their roots, to use the free nitrogen of the air. This nitrogen is given to the soil when their roots decay. Manure from the barnyard is a complete fertilizer, furnishing to the growing plant all the different kinds of food that it needs.

Physical Condition. When soil is moist, fine, and loose, it is in good physical condition, and the roots of plants penetrate it easily. The finer the soil particles, the larger the feeding surface for the roots. Grains of sand are coarser than those of clay, and therefore do not offer as large a feeding surface for plant roots per cubic foot of soil. When soil is hard or baked, roots have difficulty in penetrating it. If a soil is full of hard lumps, roots do not penetrate the lumps, and can get no nourishment from them. Sometimes the surface soil bakes before the plants come up, and they have difficulty in

breaking through it. Heavy clay soils become lumpy if plowed when very wet. Sandy soils may be plowed at any time, as the grains of sand do not stick together.

Water in the Soil. Most of the water found in the soil is held there in two conditions—(1) as free water, and (2) as capillary water. Free water is that which drains off when good drainage is provided. Capillary water is the water that is held by the soil particles, and will not drain off. Capillary water is more useful to the plant than free water, because it contains more plant food. Plant roots will not grow well in free water, as they require air; consequently free water prevents plants from becoming deep rooted.

Capacity of Soils to Retain Capillary Water. With reference to their capacity to retain capillary water, humus soil ranks highest; then in order come clay, loam, and sand. Humus soil sometimes contains its own weight of capillary water. This being true, well-rotted manure not only adds plant food to the soil, but assists in retaining moisture, thus decreasing the effects of drouth.

Uses of Soil. Soil serves as a foothold for plants, and also as a storehouse for plant food and moisture.

A Foothold for Plants. Plants send their roots into the soil, and, by so doing, are firmly supported. The wind may blow against the tall oak tree, but, notwithstanding its enormous leverage, the roots are so strong and penetrate so deep that they usually

keep the tree from being blown over. Even the roots of the fine grasses go so deep into the ground that it is hard to pull up the grass; and when enough force is applied to extract it, most of the roots break off and remain in the ground.

Food and Water Supply. Another great use of the soil is to supply plants with food and water. Water, air, and soil supply plants with all things necessary for their growth. When a plant is burned, a certain amount of ash remains. This ash represents, in large part, the food that the plant received from the soil. The remainder, or that which passes off into the air, originally came from the air, from the water, or from the humus of the soil. A very small portion of the growing plant comes from the soil. A large tree, containing several cords of wood, grows out of the ground, but takes so little substance from the soil that the ground around the tree is not lowered in the least to support the growing tree. In fact, the large roots penetrating the ground often elevate the soil somewhat. While the material supplied to the plant from the soil is small in amount, it is absolutely necessary. Soil that is not rich in plant food will not produce a good crop.

Water Supply. No matter how rich the soil may be in plant food, if it does not have a sufficient supply of moisture the crop must suffer. Plant roots cannot absorb food unless it is in solution; hence plant food must be dissolved before plants can use it. If water is present in too great a quantity, the food is too dilute, and the plants may drink in large

quantities of it, and yet go hungry. It is much the same as feeding pigs a quart of meal in a barrel of water. They may drink and drink, and still be hungry. This is one reason why soil should be drained. On the other hand, if the supply of water is not great enough for the needs of the plant, the crop suffers, not only from a shortage of water, but it gets so little water that the food supply is also too small. It is easily seen that a soil may be rich in plant food, yet, on account of the water supply being either too small or too great, the plant may suffer from a lack of nourishment.

Water May Exclude Air. If soil is very wet, the water crowds the air away from the roots of the plants. Soil in this condition is said to be water logged. This injures the plant greatly, as the roots of most plants need a supply of air. If the air is excluded from the soil, the organic matter decays very slowly, and thus the supply of available plant food is lessened. The bacteria that change nitrogen into the forms in which plants can use it do not thrive in a water-logged soil. Well-drained soil, whether the drainage is natural or artificial, is better for farm crops than soil that is very wet.

TILLAGE.

Implements of Tillage. By tillage we mean plowing, cultivating, and other processes of loosening the soil. Among the implements of tillage may be mentioned the plow, harrow, weeder, cultivator, roller, and planker. These are all so well known

to every farm boy that a description of them is not necessary.

Purpose of Tillage. Among the purposes of tillage are the following: To kill the sod on new land, to prepare a seed bed, to kill weeds, to conserve moisture, to promote movements of soil water, to aerate the soil, to change the temperature of soil, to increase bacterial action, and to promote chemical change.

To Kill the Sod on New Land. The best time of the year to break prairie sod is during the months of May and June. The plants are full of sap at that season, and quickly decompose if turned under. The breaking plow should be run very shallow, because the sod dies much more readily when the roots are cut short. Three or four months after breaking the sod, it should be backset. This is done by plowing an inch or two deeper than before. The sod is now fairly well rotted, and, if harrowed, will break up nicely and be left in good condition for a wheat crop the following year. If breaking is done in the early spring, and an attempt made to grow a crop that year, the returns are likely to be poor, because the sod is not yet rotted.

To Prepare a Seed Bed. One of the most important duties of the farmer is to prepare the seed bed thoroughly before putting in any crop. Usually the first thing done in the way of preparation is to plow the ground. This is generally the best way to prepare the soil, but disking corn ground gives it the best preparation for small grains. Care should

be taken not to plow heavy, clay land when it is very wet nor when it is extremely dry. If plowed when too wet, it will bake and form clods; and if plowed when too dry, it becomes lumpy. Sandy soil may be plowed when in almost any condition, though it is easier to plow when moist. It is not likely to bake. If there is a dry period after land is plowed, the furrow slice dries out rapidly. This can be prevented in part by harrowing the plowed ground, thus making a soil mulch that helps to check evaporation. The furrow slice itself breaks the capillarity from beneath, and so checks the loss of moisture from the soil beneath. Plowing, when done under favorable conditions, leaves the soil loose, fine, and in good condition for the seed. Fall plowing is preferred in most districts of the west. Among the reasons given are the following: It makes it possible to plant earlier in the spring, moisture beneath the furrow slice is conserved, and the surface is made rough and porous, and consequently takes in more water from the rains and melting snows of winter and spring. If the plowing for wheat is not done until spring, it must then be finished early, in order to get the crop in on time.

To Kill Weeds. Corn, potatoes, and some other crops have to be cultivated to keep down weeds. If weeds are allowed to grow with the rows of corn, they take plant food and moisture from the soil, thus leaving the crop with a diminished supply of both food and water.

To Conserve Moisture. When the surface soil

is stirred two or three inches deep with a cultivator or harrow, it is put in a condition which allows it to dry out rapidly, but these two or three inches of dry top soil keep that which lies beneath from losing its moisture. Every one has noticed how moist the earth usually is beneath a covering of straw or leaves. A soil mulch acts in the same way as a straw mulch. The earth mulch in the corn or potato field should not be more than two or three inches deep, as the fertility in the soil that forms the mulch is placed where the plant cannot get it. The cultivator shovels should not be allowed to go deep enough to cut the roots of the growing crop. During the latter part of the season, corn roots and the roots of most other cultivated crops come quite near the surface, usually within three inches of the top of the ground.

Saving Soil Moisture by Plowing. Plowing land in the fall has a very decided influence on the per cent. of water which the three or four feet of the soil nearest the surface may contain the following spring. Professor King has observed an average difference of two and one-third per cent. of the total water in the upper three feet of land plowed late in the fall, as compared with that not plowed, both of which were allowed to lie without any form of cultivation until the middle of May, the plots of land in all cases lying side by side. The quantity of water in the fall-plowed ground exceeded that in the ground not plowed by not less than six pounds, or three quarts, to the square foot. It was due to two caus-

es: (1) The loose character of the overturned soil, which caused it to act as a mulch in the fall, and again in the spring, after the snows had melted and disappeared; and (2) to the uneven surface, which tended to permit more of the melting snow and early spring rains to enter into it. The production of large crops depends very largely upon the best use of the soil moisture. The earliest possible stirring of the soil in the spring is a most important factor in holding soil moisture. The soil must, of course, be allowed to dry out enough to prevent puddling. When soil is wet and closely packed, as a result of winter snows and rains, the loss of water from evaporation is very great. It may be more than twenty tons per acre daily, and the loss may extend even deeper than four feet.

Effect of Rolling on Soil Moisture. It was once generally believed that the firming of the surface of the ground with the roller or with the wheels of the press drill increased the water content of the soil. Firming the surface does, for the time, increase the amount of water in the compacted portion. When, however, the changes in the water content in the surface four feet of soil, following the use of a heavy roller, are studied, it is found that it is another case of the movement of soil moisture,—a case where, by destroying many large noncapillary pores in the soil, and by bringing its grains more closely together, its water lifting power is increased to such an extent that often, within twenty-four hours after rolling, the upper one or two feet of

the firmed ground will contain more moisture than similar adjacent lands do at the same level, while the lower two feet have become drier. Water has been lifted from the lower into the upper soil. It is the means of borrowing water from the third and fourth feet for the surface two feet. Firming with the roller makes the rate of evaporation greater, not only by causing the water to rise to the surface more rapidly, but also by making the surface smooth, and thus increasing the rate of movement of the air along the surface of the soil, which greatly increases evaporation. It is plain, therefore, that when it is desirable to firm the surface for the purpose of increasing the amount of water in it, a light harrow should follow the roller to restore a thin mulch, which will retain the water brought up by the firming with the roller. Unless this is done, only a temporary advantage is gained. Sometimes, when a heavy rain has produced a crust over the soil, the roller leaves a partial mulch by powdering or breaking up this dried portion.

To Aerate the Soil. Stirring the soil when it is in proper condition always causes air to enter. Well-aerated soil supplies the plant roots with air, causes humus to decay more rapidly, and increases the action of bacteria generally. If the soil is well aired, it warms up more rapidly in the spring.

When Land Should Be Drained. Land should be drained when it retains a large amount of free water. Sandy land does not often need draining, because it is porous and drains naturally. Hilly or

rolling land seldom needs artificial surface drainage. Low and level land, especially when heavy in texture, and in a country where the rainfall is abundant, is benefited by drainage. It is generally true that free water should not remain closer to the surface than from three to five feet. Crops are much more likely to suffer from drouth late in the season, when free water, or the "water table," as it is called, comes near the surface early in the season. If, when the plants begin to grow, the water table is close to the surface, the roots grow down only to the free water. The roots will not grow far into free water, because there is little nourishment in it, and an insufficient supply of air. If the roots do not grow deep, the plant is likely to suffer later in the season from a lack of both food and moisture.

How Land Should Be Drained. Land may be drained either by means of tile, or by open ditches. The open ditch is much cheaper than tiling; but ditches, if near together, are a great nuisance on the farm, as they gradually fill up, and must be cleaned out, to be serviceable. Tiling, on the other hand, is expensive, and, if the soil is a hard clay, the water will drain down into the tiling very slowly, as such drains are usually several feet beneath the surface, and must always be covered with the natural soil of the field.

Deep and Shallow Tile Drainage. The depth to which water should be lowered by drainage need not ordinarily exceed four feet. There are many cases, on springy hillsides; and on flat areas between

natural elevations of ground, where the water is maintained within four feet of the surface for only a short period in the spring. In cases like these, where the water table falls naturally five to seven feet below the surface as the season advances, it is only necessary to secure drainage of the surface eighteen inches, in which the plant may begin growth. The best distance between underdrains varies with the closeness of the soil texture and the depth at which they are laid. Since the water table rises as the distance from the outlet increases, it is plain that, midway between the lines of tile, the ground water approaches nearer the surface, and, the further the drains are apart, the nearer it will approach the top of the ground.

Surface Drainage. Where very fine-textured soil occurs in extensive flat fields, it is usually desirable to adopt some form of surface drainage. Some of the compact clay soils are so impervious to water that it is useless to lay drains deep in them, even when the lines of tile are close together. Drainage into them is too slow to be of much value. In all such cases, and where drainage must be accomplished before the soil has thawed to much depth, a system of surface drainage should be adopted. This is done by throwing up road grades on the division lines, plowing fields into narrow lands, and by leaving dead furrows in the direction of the slope. With very sluggish drainage it may be necessary to connect these furrows with cross ditches, and again it may be necessary to make wide, deep, open ditches

through the fields. In all these cases, both for the wide-open ditches and those along grades, it will be well to smooth the banks and make them sloping, so they can be crossed by machinery and be cultivated across to prevent weeds growing in them. Depressions, or low places surrounded by higher land, occur where neither tile nor surface drainage will prove successful. Often in such cases the water is held by a pan of clay, which has been made by washing, while under this pan the soil is open, and capable of carrying away the water. When this is true, and the area which drains into it is not too large, it may be drained by boring or digging through the clay in one or more places, making openings for the water to escape downward. These well holes may be kept open; or, if one does not wish to leave them open, they may be filled with coarse stone or gravel, and remain very effective. When the clay is too deep to permit of draining in this way, and where the amount of water is not too large, the same result may be obtained by sinking a well or reservoir in the lowest place, into which the drains lead from various directions. The water can then be lifted by wind or other power, and used to irrigate other portions of the field.

Cost and Arrangement of Underdraining. Several forms of underdrains have been tried, but only tile drains have proved satisfactory. A mole or blind ditch can be made by drawing a blunt instrument through the ground to the depth of two or more feet. Another form of underdrain is made by filling

an open ditch with brush or stones, and covering with earth. Drains of this class last longer than the mole ditch, but are apt to clog up; and when brush is used it will finally rot and let the dirt cave in, stopping up the opening of the drain. When tile drains are used, they should be given a fall of not less than two inches per each one hundred feet, and a greater fall is better. A fall of as little as an inch to a hundred feet will work if the tile is laid on a true grade, but the expense of laying tile so carefully as is required in that case is very great. Where a continuous series of tile drains is used, the cost is very high. In one case, which Professor King gives as an example, the system cost $11.43 per acre. This was an Illinois farm, and the cost included tile, laying, ditching, and all contingent expenses. When it is a matter of draining seepy places, as in side hills, or a few wet spots in the land, the cost is smaller. It is seldom advisable to use tile smaller than three inches in diameter. In laying tile, care should be taken to have the grade nearly uniform, for when a line of tile has high and low places, whose difference is greater than the diameter of the tile, silt and mud will gather in the low places, close the drain, and render it useless. Trees should not be allowed to grow near a line of tile. They should be at least fifty feet from it; or, if trees must grow close to it, make a wooden box for the tile, to keep out the roots. Cover the opening or outlet of the tile with a screen, to keep out mice, rats, or other ani-

mals, as they are apt to clog the passage with their nests or skeletons.

Irrigation—When Practicable. Generally speaking, irrigation pays only where the rainfall is frequently deficient. If enough rain falls during the growing season to supply the crops with moisture, every effort should be put forth to see that the land is drained during the early season, so the roots will go deep; and a surface mulch should be kept, where practicable, to prevent evaporation from the surface. If the crop is likely to suffer for lack of moisture during only a part of the season, it may pay to irrigate, if the expense is not too great. It is generally practicable to irrigate when water can be obtained easily. The cheapest way to irrigate is to flood the land by damming up a stream of water, or by leading a stream of water through open ditches onto the farm. If the land is quite level, and the supply of water large and convenient, this method of irrigation costs very little. If the land is hilly or very rolling, irrigation will be more difficult. Another way to irrigate is to get a supply of water from an artesian well. This cannot be done except in an artesian district, and even then the water is sometimes so full of alkali that it is useless for irrigation purposes. Water may be lifted from a stream, in some cases, by means of a hydraulic ram. This is quite a cheap way to irrigate, as the force of the flowing water is used to lift the water for irrigation purposes. Water wheels, windmills, steam engines, and

gasoline engines are all used to supply power to pump water for purposes of irrigation.

Amount of Water Used by Crops. Professor King states that in his experiments the following amounts in tons of water to the ton of dry matter were lost by evaporation from the growing plant and the soil:

Dent corn used 309.8 tons, equal to 2.64 inches of water per ton of dry matter.
Flint corn used 233.9 tons, equal to 2.14 inches of water per ton of dry matter.
Barley used 592.9 tons, equal to 3.43 inches of water per ton of dry matter.
Oats used 522.4 tons, equal to 4.76 inches of water per ton of dry matter.

These amounts of water are needed to make good the rapid evaporation from the soil, and force the great surface exposure of the plant foliage. This evaporation is needed for the physiological or circulatory processes in the plant, which demand a large movement of water through the growing tissues. There are few countries where the distribution of the rainfall in time and amount is such as will permit fertile soils to produce the largest crops they are able to bear. This being true, the soils that can store the largest quantity of rain and other moisture, so that the plants can use it to the best advantage, are likely to be the most productive. On this account, the water-holding capacity of soils is a very important factor in determining their value.

Value of Irrigated Lands. Irrigated lands, when the soil is rich, level, easily irrigated, and easily drained, are very valuable. Under such cir-

cumstances, the growing crop need never have too much water nor too little to produce a maximum crop. With such conditions, the dryer the climate the better, because the crops can be much better cared for in dry than in wet weather, and their supply of water can be more nearly controlled.

Alkali Soils. Alkali soils are usually rich from the chemical standpoint. The trouble with them is that they contain an excess of soluble salts. These salts are sometimes alkaline, but any soil containing an excess of soluble salts is called an alkali soil. The alkali can sometimes be removed by good drainage. Where it is impossible to improve the drainage, it may be possible to remove the alkali gradually by producing and removing crops that will grow on alkali soils. If the amount of alkali in the soil is very great, it may be impossible to get rid of it.

CHAPTER XXX.

EXERCISES.

EXERCISE 1.

Purpose. To study the root system of Indian corn.

Apparatus. A few kernels of corn and a small flower pot filled with moist soil. If weather conditions are right, this experiment may be performed out of doors, in which case, flower pots will not be needed.

Directions. In the flower pot, plant about six kernels of corn at a depth of two inches. Keep the flower pot in a warm place, and water the soil often to keep it moist. At the end of five days, dig up one of the kernels. Has it sprouted? Which end of the germ extends toward the tip of the kernel? How does the kernel taste as compared with a kernel that has not sprouted? Keep observations in a note book. Three days later dig up another kernel. What is the color of the roots? How many roots has the young plant? What is the color of that portion of the stem which is beneath the surface of the soil? Above the surface? By this time all the young plants will probably have reached the surface of the soil. Now wait a week before digging up the next plant. Has it a tap root? How long are the roots? How tall is the plant? What do you sup-

pose made the roots grow down into the soil? What made the stem grow up into the air? What is the condition of the kernel from which the young plant grew? Dig up one plant each week until all are removed, and make similar observations.

EXERCISE 2.

Purpose. To study the root growth of several plants.

Apparatus. Seeds of clover, wheat, alfalfa, oats, and barley.

Directions. Plant several seeds of each kind, and note which send out tap roots.

EXERCISE 3.

Purpose. To determine which gives the strongest growth, the butt, center, or tip kernels of corn.

Apparatus. Kernels of corn from the butt, center, and tip of the ear, respectively. The rest of the apparatus may be the same as in Experiment 1.

Directions. Plant butt, center, and tip kernels of corn. Give all the same care, and note results at regular intervals.

EXERCISE 4.

Purpose. To test the percentage of germination in seeds.

Apparatus. A plate, a small quantity of sand, a sheet of paper, and seeds of various kinds.

Directions. Cover the bottom of the plate with

sand to a depth of about one and one-half inches. Moisten the sand thoroughly, and plant the seeds in it. Cover the sand with a sheet of paper to decrease

Fig. 78. Seed Germinator. A simple method of constructing a seed germinator as used in the testing of wheat and other farm seeds. It is simply a deep pie plate partly filled with pure sand, the sand covered by a circle of unglazed paper. Water enough is added to saturate the paper and the sand. The seeds are counted out in hundreds and laid on top of the paper; then the pan is covered by an ordinary tin pot lid to keep in the moisture until the seeds are germinated, when they may be counted out as "strong," "medium," "weak," "dead," etc.

evaporation. In about a week determine the percentage of germination.

EXERCISE 5.

Purpose. To learn the use of that portion of the kernel which is packed about the germ.

Apparatus. Ten kernels of corn and a small flower pot filled with moist sand.

Directions. From five kernels cut away all or nearly all the portion surrounding the germ. Now plant all ten kernels, and notice which five give the stronger growth. Why plant plump seed? Why choose large seed? Why plant small seeds shallow?

EXERCISE 6.

Purpose. To learn that plants transmit water through their stems.

Apparatus. A green stalk of corn, a basin of water, and a little red ink.

Directions. Color the water in the basin by adding a few drops of red ink. Stand the corn stalk in the basin of water, and note how rapidly the colored water rises in the stalk. What causes the water to rise in the stalk? Why do plants absorb water?

EXERCISE 7.

Purpose. To show that seeds should be kept dry while stored during the winter.

Apparatus. Ten kernels of dry seed corn.

Directions. This experiment must be performed during freezing weather. Soak half the kernels in water for three hours, and place all out of doors until thoroughly frozen. Plant and note which give the higher percentage of germination.

EXERCISE 8.

Purpose. To determine what percentage of an ear of corn is kernel, and what percentage is cob.

Apparatus. Several ears of corn.

Directions. After weighing an ear of corn, shell it and weigh the cob. What percentage of the ear is kernel? What percentage is cob?

EXERCISE 9.

Purpose. To find out if shrunken wheat will germinate.

Apparatus. Several kernels of shrunken wheat, and several kernels of plump wheat.

Directions. Plant kernels of shrunken wheat and kernels of plump wheat side by side. Note results. Which came up first? Which gave the stronger growth?

EXERCISE 10.

Purpose. To determine the effect of age on germination.

Apparatus. Kernels of wheat several years old and of known age.

Directions. Plant one hundred kernels. How many germinated? What per cent. germinated?

EXERCISE 11.

Purpose. To study the effect of darkness on plant growth.

Apparatus. Kernels of corn, a flower pot containing soil, and a fair sized box.

Directions. Plant several kernels of corn in the flower pot. About the time the corn is coming up, cover the flower pot with the box. This can be done by inverting the box over the flower pot. The box may be dispensed with if there is other means of keeping the growing plant in darkness. Examine the plant occasionally. What is the color of the leaves? What is their natural color?

EXERCISE 12.

Purpose. To study the effect of depth of planting.

Apparatus. Various kinds of seeds.

Directions. Plant the same kind of seed, one, two, three, four, five, and six inches deep. Observe results. Did all of them grow? Which came up first? Which gave the most vigorous growth?

EXERCISE 13.

Purpose. To study the effect of lack of moisture on plant growth.

Apparatus. Two flower pots full of moist soil, and several kernels of grain.

Directions. Plant about ten kernels of grain in each flower pot. Water the grain in one of the pots frequently, but give the grain in the other no water. Note the condition of the plants at the end of two weeks; at the end of four weeks; at the end of six weeks.

EXERCISE 14.

Purpose. To study the effect of cold on plant growth.

Apparatus. Two rapidly growing plants of about the same size, and of the same variety.

Directions. Keep one of the plants at room temperature, and keep the other at a temperature close to freezing. Which makes the more rapid growth?

EXERCISE 15.

Purpose. To determine approximately the number of kernels in several kinds of grain.

Apparatus. Heads of wheat, oats, barley, rye, and spelt.

Directions. Count and record the number of kernels found in each head.

EXERCISE 16.

Purpose. To learn to recognize the heads of fife and blue stem wheat.

Apparatus. Heads of fife and blue stem.

Directions. Note any points of difference. Is either variety bearded? Which has a velvet chaff?

EXERCISE 17.

Purpose. To learn to make the Babcock test.

Apparatus. For description of the apparatus and directions for performing the experiment, see text (pp. 176, 177). What is the acid used for? What would be the effect of using more acid? Of using less acid?

EXERCISE 18.

Purpose. To show that unclean milk cans cause milk to sour.

Apparatus. Two bottles, a small quantity of sour milk, and a larger quantity of new milk.

Directions. At the beginning of the experiment have both bottles clean. Rinse one with sour milk. Now fill both bottles with new milk and let stand in

a warm room for twenty-four hours. Taste, to determine which is the more sour. Note which is first to become lobbered.

EXERCISE 19.

Purpose. To determine the effect a soil mulch has on soil moisture.

Apparatus. Two glazed earthenware jars, each filled with the same quality of moist soil, preferably sand.

Directions. Pack the soil to the same firmness in each jar, and stir daily the surface one inch in one of them. At the end of two weeks observe the condition of the soil in each at a depth of two or three inches.

EXERCISE 20.

Purpose. To learn that water rises in soil due to capillary action.

Apparatus. Sand, and a basin containing a small amount of water.

Directions. Pile up the sand in the middle of the basin, and observe how rapidly the water rises in the sand.

EXERCISE 21.

Purpose. To determine the amount of water in the soil.

Apparatus. Spring balances, a small tin pail, and moist soil.

Directions. Weigh the pail, partly fill it with moist soil, weigh again, and set in the sun for several

hours. When the soil seems to be quite dry, weigh, and determine the loss of moisture. Set the pail in the sun again, and weigh occasionally until the soil reaches constant weight. The percentage of moisture is determined by dividing the loss due to evaporation by the dry weight of the soil. What is the percentage of moisture in the sample tested? To determine accurately the amount of moisture in soil, the soil should be dried at the boiling temperature.

EXERCISE 22.

Purpose. To determine the amount of humus in soil.

Apparatus. A small quantity of dry soil, an iron spoon, a bed of coals in a stove, a stove poker, a wire, and spring balances.

Directions. Tie the spoon to the poker with the wire, fill it with dry weighed soil, and place it on the bed of coals. After the organic matter has been burned out, weigh the soil again. From the loss of weight determine the percentage of humus in the soil. To be at all accurate, the experiment must be continued until the soil is burned to a constant weight.

EXERCISE 23.

Purpose. To determine the water-holding capacity of soil.

Apparatus. A quart measure and a quantity of dry soil.

Directions. Fill the measure with dry soil, and

determine how much water can be added. Place the measure in position, so that the water can drain off, and determine how much remains. The water remaining in the soil after thorough drainage is known as capillary water.

EXERCISE 24.

Purpose. To study the effect of a lack of fertility in the soil.

Apparatus. Two flower pots, sand, rich soil, and kernels of grain.

Directions. Plant seeds in sand and in rich soil, and observe which gives the stronger growth during a period of six weeks.

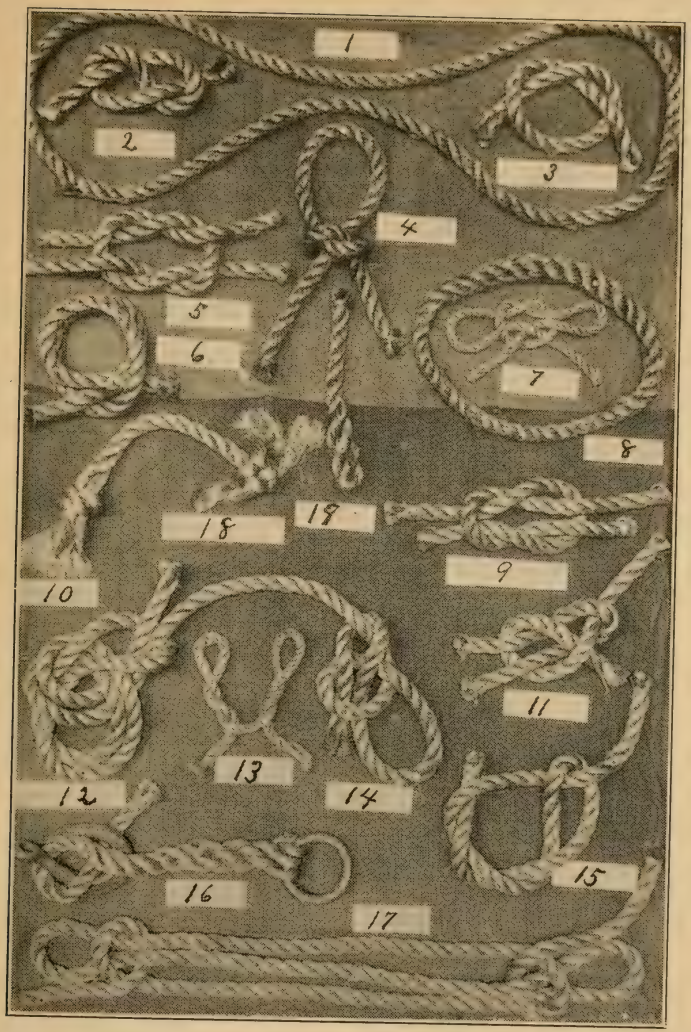
EXERCISE 25.

Purpose. To show the value of drainage.

Apparatus. Plants growing in flower pots.

Directions. Keep the soil in one of the flower pots constantly flooded, and keep the soil in the other moist. What is the effect of an excess of water?

1. Long Splice.
2. Figure Eight Knot.
3. Simple Overhand Knot.
4. Single Bow Knot.
5. Granny's Knot.
6. Clove Hitch.
7. Butcher's Hitch.
8. Short Splice.
9. Square or Reef Knot.
10. Wall Knot.
11. Weaver's Knot.
12. Bow Line on a Bight.
13. Cat's Paw.
14. Bow Line Knot.
15. Timber Hitch.
16. Blackwall Hitch.
17. Sheep Shank.
18. Wall Knot—With Crown.
19. End Splice.



For a Detailed Explanation of the Way to Tie These Knots, See "Rural School Agriculture," Issued by the Minnesota Agricultural College.

CHAPTER XXXI.

CORN-GROWING CONTESTS.

During the summer of 1904, the pupils in the public schools of Traill county, under the leadership of Supt. Hetler, carried on the first corn-growing contest that has been held in this state. On account of the success of this experiment, seven counties in North Dakota are holding pupils' corn-growing contests this year (1905). Rules similar to those given below may be used to govern these contests.

1. All pupils regularly enrolled in the common schools are eligible to take part in the contest.

2. No seed shall be used except that furnished by the county superintendent.

3. Four kernels must be planted in each hill.

4. The hills must be approximately three and a half feet apart each way.

5. One hundred hills must be planted in the form of a square, making the plot ten hills on a side.

6. The seed remaining is to be planted on the south, west, and north of the plot to protect and fertilize the corn growing on the plot.

7. The corn is to receive careful cultivation, all such work to be done by or under the direction of the pupil taking part in the contest.

8. Ten ears are to be selected from those grown

on the plot, and exhibited at the time and place designated by the county superintendent.

9. A careful record is to be kept of the experiment. This record shall include the date of plowing, time and manner of planting, frequency of cultivation, etc.

10. Each student taking part in the contest is to write an account of not less than three hundred words, telling about the experiment.

11. The corn is to be judged according to the score card used at the North Dakota Agricultural College.

CHAPTER XXXII.

LEGAL WEIGHTS.

What constitutes a bushel in North Dakota. Approved by the governor of North Dakota, March 4, 1903.

Barley, 48 lbs.
Beans, 60 lbs.
Bran, 20 lbs.
Buckwheat, 42 lbs.
Beets, 60 lbs.
Broom-corn seed, 30 lbs.
Corn (shelled), 56 lbs.
Corn (in ear), 70 lbs.
Coal (stone), 80 lbs.
Flaxseed, 56 lbs.
Lime, 80 lbs.
Oats, 32 lbs.
Onions, 52 lbs.
Potatoes (Irish), 60 lbs.
Potatoes (Sweet), 46 lbs.
Peas, 60 lbs.
Rye, 56 lbs.
Salt, 80 lbs.
Turnips, 60 lbs.
Timothy Seed, 45 lbs.
Wheat, 60 lbs.
Millet, 50 lbs.
Apples, 50 lbs.
Bromus Inermis, 14 lbs.
Spelt, 40 lbs.

ACKNOWLEDGMENTS.

Since the plan of preparing a manual of agriculture for the use of the public schools of North Dakota was first conceived, President J. H. Worst has regularly aided in the consummation of the work by helping to outline the plan and scope of a volume designed to meet the requirements. It would be impossible to come into contact with so enthusiastic a friend of agricultural education without receiving many helpful impulses, which are absorbed and in this case have become a corporate part of the written page.

The authors are indebted to Professor E. F. Ladd for numerous suggestions relative to the plan and detailed arrangement of the book, and for a hearty moral support in every feature pertaining to the publication.

Professor C. B. Waldron furnished the material incorporated in the chapters given upon Home and School Grounds, Injurious Insects, and Fruit Culture.

For the sake of a goodly degree of unity in the plan of presenting the different subjects, it has been necessary to clothe the articles furnished by our co-laborers in language which will harmonize in out-

line and general form of composition with other features of the book.

Professor H. L. Bolley aided the writers by supplying material upon the subjects treating of potato scab, wheat smut, and flax wilt, in addition to the discussion upon the nature of the cereal rusts.

Superintendent L. R. Waldron aided by furnishing us with carefully prepared matter upon Weeds and Bird Life.

Our colaborers in the agricultural division of this institution have helped in the preparation of the material in a very effective manner.

Professor W. B. Richards aided most cordially in the preparation of the chapter upon Horses, and served us by securing the animal photographs from which engravings have been made.

Professor O. O. Churchill rendered us especially valuable aid by taking photographs used in the preparation of the illustrations appearing in the foregoing pages, and by making criticisms and suggestions relative to the articles presented upon the various farm crops.

Mr. Nicholaus Grest furnished the matter which formed the basis of the discussion upon Road Construction and the Care of Farm Machinery, while Mr. Oliver Dynes rendered effective aid in the preparation of the chapter upon Poultry. The support and encouragement which the writers have received from all members of the faculty and station staff of the North Dakota Agricultural College and Experi-

ment Station during the preparation of this volume, deserve special mention and recognition.

An association with the veteran agricultural editor—Orange Judd—as a member of his editorial staff, gave the writers a familiarity with successful methods of presenting scientific facts in an elementary form which has been of great service to us in the preparation of this publication. Editor M. F. Greeley, of the Dakota Farmer, who has given the subject of public school agriculture much thought, has materially aided and encouraged the writers with suggestions and advice relative to the subject-matter presented in the foregoing pages. It is a pleasure to acknowledge our indebtedness to these men, who have devoted their lives to writing agricultural truths in an elementary and attractive form for the masses engaged in the occupation of farming.

It is impossible for the writers to know how much to credit the incentives received from contact—in the position of students in agriculture—with Secretary James Wilson and Dean C. F. Curtiss, at the Iowa Agricultural College, how much the enthusiasm of Assistant Secretary Hays inspired us while sitting in his classes in the College of Agriculture of Minnesota; neither can we assign the part which should be credited to Dean W. A. Henry, to Dr. S. M. Babcock, to Dean John A. Craig, now of the Texas College of Agriculture, and to Dean W. L. Carlyle, of the Colorado Agricultural College, as the result of a daily contact with them in the classes

of the agricultural department of the University of Wisconsin. That an intimate association with such eminent authorities upon the subject of agriculture cannot fail to enkindle the flames of ambition and a love for the calling, and add to the resources of their students, none will question, and the authors take this occasion to make due acknowledgment of the fundamental way in which these gentlemen have had a part in the production of this book.

J. H. SHEPPERD.
J. C. McDOWELL.